TREATISE

ON

PHOTOGRAPHY,

BY

CHARLES WALDACK.

FOURTH EDITION.

CINCINNATI:
H. W[illegible], Printer, No. 60 West Third Street.
1865.

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FOURTH EDITION.

CINCINNATI:
H. Watkin, Printer, No. 60 Third St., near Walnut.
1865.

PREFACE.

NUMEROUS changes have been made in this edition. Matters become obsolete have been suppressed, and improvements in the processes generally practiced have been described. We have not noticed, however, any of the new processes in printing, which have lately made their appearance. The processes of carbon printing we consider not yet sufficiently practical to be of use to the professional photographer. We thought of being able to give a method superior to the ordinary printing process, and even, on this account, retarded the publication of this edition; but the process in question turned out to have been greatly overrated. We refer here to the *Wothlotype* process, the appearance of which created such an excitement in the photographic community. The results obtained by this process do not meet the anticipation of photographers. Prints made by it possess no advantage over those made in the ordinary way, neither in quality, facility of manipulation, cost, nor permanency. Our aim being to bring forth a guide for practical photographers, we have thus omitted a description of it, and devoted our space to objects of more direct value.

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TREATISE ON PHOTOGRAPHY.

CHAPTER I.

History of Photography.

The art of photography (from the Greek φῶς *light*, and γράφω *print*,) includes all processes by which images or impressions are obtained through the agency of light. The application of the action of light to this purpose is but of recent introduction.

The ancients do not seem to have directed their attention to the modifications brought on by light, in the physical and chemical conditions of certain bodies. The only phenomenon recorded by them is the loss of brilliancy of certain precious stones, such as opal and amethyst, by a prolonged exposure to the sun's rays. In the middle ages some of the alchemists noticed the fact that the fused chloride of silver, called by them *horn silver* or *horn moon*, blackened under the influence of light.

In 1722, Petit remarked that certain salts, such as the nitre and sal ammonia, crystalized easier being exposed to the light.

In 1765, the celebrated German chemist, Scheele, made a more scientific examination of the action of light on the silver compounds, and discovered that the chloride of silver black-

ens more rapidly in the violet, than in the red ray of the spectrum.

The first attempt at photographing was made by Wedgewood, in 1802. He succeeded in making silhouettes by projecting the shadow of the object on paper dipped into a solution of nitrate of silver; the part on which the shadow fell remained white, while the one exposed to the light blackened. The image thus obtained was immersed in water, which dissolved the unreduced nitrate of silver. Wedgewood and Humphrey Davy tried to copy landscapes in the camera obscura by the same process, but did not find it sensitive enough. Davy, however, succeeded in copying the enlarged images obtained with the solar microscope.

Joseph Nicephore Niepce of Chalons, France, is the first one who succeeded in fixing the image of the camera obscura. His process was based on the property of the bitumen of Judea, or asphaltum, to become insoluble in certain essential oils under the influence of light. Niepce dissolved the asphaltum in lavender essence, and spread it on the surface of a silvered copper plate; when dried, the plate was exposed in the camera obscura for several hours, and then washed with a mixture of petrol oil and lavender essence, which had the effect of dissolving the unalted asphaltum. In the image thus obtained, the lights were formed by the undissolved bitumen, and the shades by the silver.

In 1829 Niepce associated with Daguerre, who had labored to attain the same object, but their combined efforts did not result in improving the bitumen process so as to make it practicable.

In one of their experiments, they used the vapor of iodine to darken the shades of their bitumen pictures, and observed that the iodide of silver thus formed was altered in color by the light. It is this fact, which is said to have changed the direction of Daguerre's investigations, and to have been the first step towards the discovery of the Daguerreotype.

It was only after the death of Niepce, that Daguerre, continuing his experiments, discovered the process which bears his name. Daguerre's sensitive iodide of silver was prepared by exposing a well polished silver plate to the vapor of iodine. The plate was exposed in the camera obscura for a relatively short time, and then was submitted to the vapor of mercury, which brought out the latent image. The mercury combining with the parts affected by the light, formed the lights, while the black appearance of the burnished silver, which had not been impressed, constituted the shades. The unaltered iodide of silver was then rendered insensitive by washing the plate with a solution of common salt.

The publication of Daguerre's process in 1839, produced an immense sensation. At no time and on no occasion before was a greater

interest manifested by the lovers of art and science. Men of science and artists of reputation embraced the new art with enthusiasm, and in a short time, the Daguerreotype became the beautiful process as it is now practiced.—Daguerre himself did but little to perfect it.—Baron Seguier, Foucault, etc., perfected the apparatus. Herschel substituted hyposulphite of soda for the common salt used for fixing the image. Fizeau discovered the means of gilding the image and in this way gave it more brilliancy and durability.—Claudet discovered the first accelerating substance used, the chloride of iodine, and Fizeau again used the vapor of bromine to the same purpose, and thus reduced the time of exposure in the camera to a few seconds. After that followed the discovery of the dry accelerating substances, bromide of lime and chloro-bromide of lime (improperly called), the numerous improvements in the apparatus, by which the tedious process as described by Daguerre was reduced to its utmost simplicity, etc.

Thus, in a few years, the process of Photography on silver plates became the simple and practical process which to this day has not had its superior in sharpness, definition and brilliancy.

While Daguerre was prosecuting his researches in France, Fox Talbot was continuing in England the researches of Wedgwood and Davy. In January1839, seven months be-

fore the publication of Daguerre's process, Mr. Talbot made his first communication to the Royal Society of London. In this communication, he made known his process of copying by application. A sheet of paper is firstly brushed over with a solution of chloride of sodium (common salt) and then with a solution of nitrate of silver. In this way is formed in the texture of the paper a white precipitate of chloride of silver, a compound much more sensitive than the nitrate of silver employed by Wedgwood and Davy. The object to be copied is laid on the prepared paper and exposed to the light. The light passes through the transparent parts, and blackens the paper, leaving unaltered the parts through which it cannot penetrate. In this way an image is obtained with the lights and shades reversed, which Talbot called a *Negative.* This negative being laid on a second sheet of paper, prepared in the same way as the first, and the same operation being gone through, a natural representation of the object is obtained, which is called *Positive.*

In February 1841, Talbot took his patent for the Talbotype or Calotype process. In this process, the paper is first brushed over with nitrate of silver, then with iodide of potassium and finally with gallo-nitrate of silver, (a solution of gallic acid and nitrate of silver.) It is then exposed in the camera, developed with a fresh solution of gallo-nitrate, and fixed in

a solution of bromide of potassium. The image produced is negative, and positives are copied from it by means of the chloride of silver paper spoken of above. The Talbotype process was modified and perfected by Blanquart Evrard, Humbert de Molard, Baldus, Legray, etc. It is a modification of the Talbotype process, which is now generally used in printing enlarged pictures.

We will not in this work enter into the many details of the Calotype process. The different negative paper processes are more suited to monumental photography than to the reproduction of natural scenery. Our modern public edifices, the elegant and tasteful dwellings of our wealthy citizens, the luxuriant vegetation of our landscapes are bad subjects to be photographed. Their reproduction presents difficulties which can only be overcome by means of the collodion process. The processes of Legray, Baldus and others, present thus too little interest to our American photographers to speak at length of them in this work.

Fox Talbot must be considered as the inventor of what is commonly called *photography*, which comprises the different processes on paper and on glass. The waxed paper, the albumen and the collodion processes rest on the same basis as the process he patented in February, 1841, viz: formation in paper, albumen or collodion of iodide of silver with presence of nitrate of silver, moleculary alteration or partial

reduction of the sensitive surface by the light, development or bringing out of the latent image by means of gallic acid, pyrogallic acid or protosulphate of iron, finally desensitizing or dissolution of the unaltered iodide by means of bromide of potassium, hyposulphite of soda, cyanide of potassium, etc.

The prints made from paper negatives, owing to the coarse and irregular texture of the paper, being very inferior in sharpness and definition to the daguerreotypes, Sir John Herschel suggested the use of glass plates.— Soon after Niepce de St. Victor, the nephew of John Nicephore Niepce discovered the Albumen process, in which the iodide of silver is retained on the plate by means of a layer of white of egg. This beautiful process, most simple in theory, but the most difficult in practice was perfected by Messrs. Bayard, Humbert de Molard, Martens, Lemoynne, Whipple, etc. The objections to this process are the difficulty to avoid dust and the length of exposure that is required.

In 1850 Legray suggested the use of collodion instead of albumen, but Archer was the first who carried out the idea so as to present to the photographic world a well defined process.

The discovery of the collodion process is the most important that has been made in photography since the discovery of the Daguerreotype. It has given an immense im-

pulse to the art. It is certainly the simplest and most successful process in use, and is suited to almost any condition of light and temperature.

From the time the collodion process first came into use attempts have been made to preserve the sensitiveness of the film, so as to be able to leave a certain time between the preparation of the plate and the exposure, and between the exposure and the development. Mr. Shadbolt first succeeded in this by covering the sensitized plate with diluted honey, thus keeping it moist. This process is now abandoned, and processes in which the plate is washed and dried have come into general use. Amongst these we will cite Taupenot's collodio-albumen process, Hill Norris' gelatine process, Fothergill's, Sutton's, Major Russell's and others. Major Russell's process, in which tannin is used as a preservative, is the most popular, and very successful. By some modifications introduced in its practice, good results have been obtained with an exposure not much longer than that which is generally given for wet collodion.

The attention of scientific photographers has been directed, for the last few years, to the means of preventing the fading of photographic prints. The researches of Messrs. Barreswil and Davanne, Hardwich and others, have shown the real causes of the fading.

Now that the old processes of toning and fix-

ing together have been abandoned, and the separate toning and fixing has been generally adopted, prints are made more permanent than they used to be. Many photographers, however, use their fixing bath so injudiciously that the prints they produce are little better than those by the old method.

Some experimenters have discovered processes in which the salts of silver are not used. The most noted one is the *carbon process*, but the prints obtained by it cannot compete for beauty with those obtained by the ordinary processes. In our opinion the true progress of photography lays in another direction. We refer to the production of the print in printer's ink. The process of photo-zincography used at the ordnance survey office in Southampton, and which is the invention of Col. H. James and Capt. A. De C. Scott, gives, in the hands of these gentlemen, very promising results. The same may be said of Mr. Osborne's photolithographic process, which is used in the survey office in Melbourne, (Australia.) Both processes are nearly the same, and are subject to the same objection, the difficulty in obtaining half tone.

CHAPTER II.

PHILOSOPHY OF LIGHT—DECOMPOSITION OF LIGHT—ITS ILLUMINATING, HEAT PRODUCING AND ACTINIC PROPERTIES—INVISIBLE RAYS—REFRACTION—LENSES—THE PHOTOGRAPHIC CAMERA.

When a pencil of sunlight is made to fall upon one angle of a *prism*, it is decomposed and forms on a screen placed at a distance an image of the seven primitive colors in the following order: Violet, Indigo, Blue, Green, Yellow, Orange and Red. This image is called the *Solar Spectrum.* This experiment which was first made by Newton, proves that the light of the sun is composed of seven different rays each producing a different illumination. Some Philosophers admit only of three primitive colors, blue, yellow and red, and contend that the violet, indigo, green and orange are formed by two or more of these overlapping each other, red and yellow forming orange, yellow and blue forming green, etc.

When white light falls on opaque bodies, some of the rays are absorbed, others are reflected. A red surface thus reflects the red ray and absorbs the others, a blue surface reflects the blue ray, white surfaces reflect the light without decomposing it, while black ones absorb all the rays.

The same phenomenon takes place when white light is transmitted through transparent or translucid bodies. While white glass will

thus transmit the light without decomposition, orange glass will only transmit the orange ray, blue glass only the blue ray.

The compound light produces three effects: it illuminates, it produces heat, and it has a chemical power commonly called *actinism.*

The power of illuminating resides mainly in the yellow ray, the part of the spectrum occupied by that ray being the brightest. The heating properties are predominant in the red ray; a thermometer held in that part of the spectrum indicates an increase of temperature.

The most intense actinic power is to be found in the blue, indigo and violet rays. Thus, when a sheet of sensitized paper is exposed to the decomposed light in the spectrum, the action will be found to be the most energetic in the space occupied by these rays. But this action is not confined within the limits of the spectrum, for the paper will be impressed also beyond the violet where the eye perceives no light. The actinic rays which produce this are called *invisible*, or dark rays.

When the light passes from one medium into another, one part of it is reflected, the other part entering the new medium is bended.

Refraction is the property which light possesses of deviating from its primitive direction, on passing from a medium of a certain density into another of different density. The effects of refraction are illustrated by some very simple experiments. If a stick be put into the wa-

ter it will seem to be broken in two. If a coin be dropped into a tub of water, it will appear much nearer the observer than it really is. By the effect of refraction, a fish will appear nearer the surface, a basin or a river will not appear as deep as it really is. We see the stars at their rising, before the moment the rays emanating from them can arrive in a straight line within the reach of our vision, because these rays are refracted by entering the atmosphere which surrounds the globe.

When a ray of light falls upon a lens, the phenomenon of refraction takes place. The ray bends on entering the lens and bends again on leaving it. The form of the lens determines the direction of the refracted rays.

Convergent lenses are those which refract the rays so as to condense them to a point, *divergent* lenses are those which scatter them.

A *biconvex* lens is one which is convex on both sides. A *biconcave* lens is concave on both sides. A *meniscus* lens is convex on one side and concave on the other, but more convex than concave. A *plano-convex* lens is plane on one side and convex on the other.—The bi-convex, meniscus and plano-convex lenses condense the light to a point and are thus convergent, the bi-concave and plano-concave lenses scatter it and are therefore divergent.

The point at which rays of light are brought

together by convergent lenses is called the *focus.*

When rays of light proceed from very distant objects, they are parallel, or may be considered so. Parallel rays, entering a convergent lens, are brought to a focus at a point nearer the lens than rays which proceed from a small distance and are divergent. The nearer the object from which the rays proceed the farther the focus is from the lens. The sun's rays which are parallel, condense to a point which is called the *principal focus.* It is to this point that reference is made in speaking of the *focal length of a lens.*

When a ray of light proceeds from a near point, and passing through a lens, comes to a focus at another point, these two points associated are termed *conjugate foci.*

The nearer the object is to the lens, the farther its focus will be removed from it, and the larger the image will be.

The more convex the lens is, the shorter the focus, and the smaller the image it gives.

The *Photographic Camera,* in its most simple form, is a box composed of two compartments, the one sliding into the other, one compartment having a lens adapted to it, the other being furnished with a ground glass, which can be removed and a tablet holding the sensitive plate put in its place. When this camera is pointed towards an object the focus is found by sliding the compartment to which the

ground glass is adapted, forwards and backwards, till the point is found where the image is the most distinct.

The image formed on the ground glass is more or less flat or curved, sharp or indistinct. This depends on the construction of the lenses or object-glasses. An object-glass, which gives an image of which nearly all the parts can be brought to a focus at the same point, is said to have a flat field. Object-glasses giving very sharp images, have generally a curved field, so that when the center of the image is in focus, the extremities are not. Flat fields, on the other side, are obtained at the expense of sharpness.

The want of definition of one part of the image, when the other is sharp and distinct, is due to two causes. The first one is the unequal refraction of the rays of light, resulting from the spherical form of the lenses, and is called *spherical aberration*. The second cause, is the obliquity of some rays proceeding from the object. This indistinctness of the edges of the image, can be corrected by covering the edges of the lens, in which the spherical aberration mainly resides, and admitting the light only through the center. This is done by fixing in front of the lens a disc of metal or cardboard with a circular or square opening in the center. This disc is called *stop* or *diaphragm*. The effect of a stop is also to make the field flatter, by intercepting a portion of the oblique

rays, and thus lengthening out the focus of the remainder. These effects are produced to a greater extent in proportion as the diaphragm is smaller. But in the same time, the quantity of light admitted into the camera, being diminished, the image is less illuminated, and the sensitive plate requires a longer exposure.

In such conditions, when the use of diaphragms is not practicable, it is necessary to use lenses, with the least possible spherical aberration. The manufacture of such lenses is a work of great skill and difficulty, and requires extraordinary care.

Ordinary lenses refracting the light, decompose it, and give images fringed with color. This effect is called *chromatic aberration*, and is corrected by the combination of two lenses of different density; a bi-concave flint, and a bi-convex crown, sealed together, so that they form a meniscus, which is called *achromatic.*

The achromatic meniscus, in order to give the desired sharpness and field, requires to be diaphragmed, but as the diaphragm shuts off a large part of the light, it makes it impossible to use this combination to reproduce images of objects which require rapidity of action.

The portrait tube, or object-glass, is a double combination of lenses. The front combination is a bi-convex crown, sealed to a plano-concave flint, and has the crown lens turned towards the object; the back combination is composed of a bi-concave flint, slightly separated from a

bi-convex crown by means of a ring, the crown lens facing the ground glass. The distance between the two compound lenses is determined by calculation.

The portrait combination is generally used without a diaphragm, so as to allow a short exposure of the sensitive plate, by admitting a large volume of light.

The most essential conditions required in a portrait tube, are: rapidity of action, sharpness, and depth of focus. The most important one is the last, as without it, the production of good portraits is impossible, those parts only on which the focus has been taken coming out sharp and distinct, and the other being distorted and out of focus. It is for want of depth of focus, that in so many portraits the hands, and other parts, are out of shape, and a great deal larger than they are in nature. This defect can be obviated, to a certain extent, by setting the subject so that his body describes a segment of a circle, as far as this is competent with a good and easy position. Operators possessing instruments which have this defect should diaphragm them as much as their light and the sensitiveness of their plates will allow, and they should not attempt to make large heads, if they want to have good likenesses.

The portrait combination can be used also for views, by inserting a small diaphragm between the lenses; or the back lenses may be

removed, and the front lens turned with the plane side towards the object, in which case, a diaphragm has to be adapted in front.

The refraction of the light through a lens, which produces chromatic aberration, separates also the visual from the chemical focus. We have seen that the most intense actinic effect resides in the violet ray, and beyond it, and that the most luminous portion of the spectrum is the space occupied by the yellow ray. The violet ray being more refrangible than the yellow ray, will be more strongly bent, and the two rays will be brought to a focus at two different points. The most intense chemical action will thus not take place at the point where the image is the sharpest, but at a point nearer the lens; and whenever lenses are used, which are not strictly achromatic, the slide containing the sensitive plate should be shifted to that point. In the lenses made by good manufacturers, however, the visual and chemical focus are made to correspond.

CHAPTER III.

General Theory of the Collodion Process.

Collodion is a solution of Pyroxyline or Guncotton in a mixture of Sulphuric Ether and Alcohol.

Iodized collodion, is collodion in which a certain quantity of some *Iodide* has been dissolved, the iodide of potassium, for instance.

If a glass plate be coated with this iodized collodion, and, after part of the ether and alcohol are evaporated, be immersed into a solution of nitrate of silver, the iodide of potassium and nitrate of silver will decompose each other and will produce iodide of silver, which will be retained on the plate by the film of the collodion. In this state, the film will present a blue, white, or creamy opaque appearance according to the quantity of iodide of potassium dissolved in the collodion. This operation has to be done in a dark room by artificial light. If we now expose this plate in the camera, the film will be impressed by the rays of light, strongly in the clear parts, to a smaller extent in the darker. In examining the plate at this moment, it will be found to have the same appearance as before, presenting no trace of an image. A latent image exists however, which has to be brought out by means of a developer. The developer, in the collodion process is either protosulphate of iron or pyrogallic acid. If then, we pour a solution of protosulphate of iron on the plate, the image will appear, presenting the most intensity in those places where the light was the strongest. This image is formed by metallic silver in a minute state of division retained on the plate by the film of collodion. At this

period we have on the plate metallic silver and iodide of silver which have not been acted upon. What remains to be done is to take away this Iodide of silver by dissolving it in cyanide of potassium or in hyposulphite of soda.

Let us now examine the picture which we have obtained, by holding it up to the light. We will observe that the light parts present a certain opacity and that the shadows are transparent. If on the contrary, we examine it by reflection we will find that the light parts appear white and the shadows black. The former appearance of the picture is called the *Negative*, and the latter the *Positive*.

All collodion pictures made on transparent surfaces such as glass, etc., present both aspects. Those made on japanned iron plates or on black paper, can only be viewed as positives. In practice, the name of *positives* is given to such pictures on glass, iron, paper, etc. that are designed to be viewed by reflected light. On the contrary, *negatives* are judged of by transmitted light and are a kind of *type* or *matrix*, with which pictures on paper have to be produced by means of a peculiar printing process.

Although a collodion glass picture presents both aspects, the positive and the negative, it cannot be used in both qualities. A good positive picture has never opacity enough in the light parts to be used for making prints;

and a negative picture, viewed by reflection is imperfect, owing to the absence of good blacks and of details in the light parts. Both kinds of pictures are produced by the same process, but different conditions of the chemicals are required.

For the positive picture, the silver reduced on the surface of the plate has to be in a small quantity only; for the negative picture, it is to be so thick that it obstructs the light to a considerable extent in the light parts. The quantity of reduced silver, or the intensity of the image, depends; 1st, on the peculiar qualities of the soluble cotton; 2nd, on the thickness of the collodion; 3d, on the amount of bromide dissolved in the collodion; 4th, on the condition of the silver solution and of the developing solution; 5th, on the length of exposure in the camera.

CHAPTER IV.

On the different Compounds used in the Production of Collodion Pictures.

Before we enter upon the practical details for the production of collodion pictures, we will give, first, the preparation of the different solutions to be used. These are taken in the following order: 1st, the collodion, 2nd, the silver solution; 3d, the developing solution; 4th, the fixing solution.

The collodion is the menstruum used to retain the sensitive compound on the glass, or on the iron plate; the silver solution, in combination with the iodine, which is in the collodion, forms the sensitive compound; the developing solution brings the latent image out; and the fixing solution removes from the film the unreduced sensitive compound.

CHAPTER V.

On Positive Collodion Pictures.

A positive collodion picture is understood to be a collodion picture viewed by reflected light. Positive pictures are made on different materials. Those most commonly used are white or colored glass, japanned iron plates, or cardboard prepared in a similar way, mica, etc. Positives made on glass are generally called *Ambrotypes*, a name originally only applied to such pictures as were sealed to another plate of glass by means of *balsam of fir*, and in this way were kept from deteriorating influences. Pictures made on iron plates are called *Melainotypes* or *Ferrotypes;* and those made on card board or paper covered with asphaltum varnish, are known by the name of *Niellographs*. The use of black paper and mica is now almost entirely abandoned, professional photographers confining themselves to the glass and iron plates.

The pictures on iron plates and on black paper are like the daguerreotype reversed, that is, the image is the same as seen in a looking glass, the right side being left, and the left right. The ambrotype alone can be mounted so as to give an exact representation of the subject, and in that case the black varnish, velvet or paper have to be applied on the collodion side, and the color that may be put on the picture, will not show through the film. The fact of the melainotype and niellograph being reversed is not objectionable in most cases in portraits, but is decidedly so in views and in this case a parallel reflector, or a prism will have to be used to invert the image, or the picture will have to be made on glass.

In our opinion the melainotype, covered with benzine varnish, is the most durable picture of all, as much because of the durability of the material on which it is made, as from the great adherance of the collodion film and varnish to the japanned surface. We never knew a melainotype picture to crack off, while this is quite common with the varnished glass pictures, which are exposed in show cases to the inclemency of the weather. The iron plate is further incomparably easier to manage than glass; it can be grasped by the pinchers, cut, heated for drying and varnished with ease and safety, and the subsequent varnishing on the back, in mounting positives on glass, after the impression is obtained, is

avoided by its use. Another advantage is, the facility with which the plates are cleaned, a piece of canton flannel, and a few drops of alcohol, are all that is required for the purpose.

What has been said of the melainotype plate, is applicable in a great measure to the niello paper. However, the material of which it is made is not as durable, and the paper plates present the inconvenience of floating in the silver solution, so that they have first to be stuck on a glass before they are immersed in it.

Sometimes pictures are first made on glass, and then transferred on oil-cloth, or on patent leather. They are not reversed, and require no varnishing, the metallic silver forming the picture being protected by the part of the collodion film which adheres to the glass. These cannot be colored.

CHAPTER VI.

On Collodion.

Three compounds enter into the preparation of collodion; ether, alcohol, and pyroxyline or soluble gun-cotton.

Ether.—(Commonly but improperly called sulphuric ether.) The purity of the ether is a matter of great importance, in the preparation of good collodion. It must be concentrated,

free from much alcohol and water, without disagreeable smell, and free from acetic and sulphuric acids.

Three kinds of ether are ordinarily found in the trade.

First, the common ether, which contains a variable quantity of alcohol and water, and presents ordinarily an acid reaction with litmus paper, from the presence of sulphuric acid. Ether in this state is unfit for use.

Second, the washed ether, or ordinary ether which has been agitated with a certain quantity of water, to take away the alcohol and the acid. This might be used in connection with very strong alcohol, and cotton of good quality, if it was washed so thoroughly as to present no longer an acid reaction to test paper.

Third, ether both washed and redistilled, on unslacked lime or on potash, which deprives it of its water, and neutralizes any acid it may contain. This ether is the best for use, and should always be procured if possible. When entirely pure, its specific gravity is 720, but, it is but seldom found at that strength. The ether expressly prepared for photographic purposes, by reliable chemists, has a specific gravity of about 725. The minimum of strength of the ether to be used depends entirely on the strength and quantity of alcohol used in connection with it, to dissolve the pyroxline.

If the practitioner cannot find any ether strong enough for use, he may take the com-

mon or washed ether and deprive it of its water by digesting it with good white unslacked lime. The effect of the quick lime is to absorb the water and neutralize the acid. The ether should be put in a bottle, and the lime added to it by small quantities at a time, and at intervals of half an hour, shaking after each addition. The quantity of lime to be used is two or three ounces to a pound of ether. After all the lime has been added, let it digest for a day or two, shaking occasionally, after which the ether will be deprived of its water. The clear liquid can then be poured off and kept for use. It will happen, sometimes, that the lime absorbs the water very quickly, which produces an elevation of temperature. If so, great care should be taken not to add too much lime at a time, for the ether, being very volatile, might blow off the cork of the bottle.—The ether, concentrated this way, is slightly alkaline, but the alkalinity is removed easily, by adding hydrobromic acid to the collodion till it takes a yellow straw color after being kept a few hours.

Ether which is exposed to the light and to the contact of the air, will decompose and generate acetic acid. In this state, it is unfit for photographic purposes. It is necessary for its preservation, to put it into well corked bottles, and to keep it in a dark place.

Alcohol.—It is necessary to use the purest alcohol, not weaker than 90 per cent, when it

is used with ether 725, and stronger when it has to be used with ether of a greater specific gravity. It should also be free from essential oil. Quick lime will bring common alcohol to a standard suitable for photographic purposes. It should be used in the same proportion, and in the same way, as for the concentration of the ether.

Pyroxyline or soluble gun cotton.—Pyroxyline made from cotton has the same appearance and physical properties as ordinary cotton, with the difference that it is somewhat more rough to the touch and that it grates in being pulled apart through the fingers.

Pyroxyline is the result of the action of nitric acid on ligneous substances, such as cotton, paper, linen, wood, etc.

For the manner of its preparation, we refer the reader to the '*Chemistry of Pyroxyline.*'—We will only say here, that it is produced by immersing the cotton in a mixture of nitric and sulphuric acids.

The quality of the soluble cotton depends, 1st, on the strength of the acids. 2nd, on the temperature of the acids during the immersion.

The strength of the acids determines the more or less solubility of the cotton. Cotton immersed into a mixture of nitric and sulphuric acids of the maximum of strength is explosive, but insoluble in the mixture of ether and alcohol. In proportion as the strength of the acids is reduced by the addition of water,

the cotton becomes less explosive and more soluble, till it reaches a certain point, when the solubility decreases. Thus both strong and weak acids give insoluble or imperfectly soluble cotton. The one obtained by strong acids is more or less explosive; the one obtained by weak acids burns without explosion.

The temperature of the acids during the immersion, the acids supposed to be of the proper strength, determines the physical properties of the plain collodion. Pyroxyline made at the maximum of temperature, gives a collodion presenting the following peculiarities; 1st.—When added to the ordinary proportion of ether and alcohol, it falls to the bottom in a gelatinous mass, and dissolves only after considerable shaking. 2nd.—It yields a fluid solution, and requires to be used in a comparatively large quantity to make a collodion of the proper thickness. 3rd.—It gives a collodion spreading into a smooth and glassy surface. 4th.—The film it gives is short, adherant to the glass, and porous.

Pyroxyline made at a low temperature, presents the opposite characteristics. 1st.—It dissolves in the mixture of ether and alcohol without gelatinizing. 2nd.—It gives a thick and glutinous solution. 3rd.—It gives a collodion spreading over the glass in a slimy manner, and setting into numerous small waves. 4th.—The film is tough, contractile,

coherant, apt to get loose from the glass and devoid of porosity.

When acids of the minimum of strength, and at a high temperature act on cotton, it is liable to be partly decomposed and the collodion made with it will be porous to a high degree. Such cotton will have a short texture, and sometimes, give a rotten film, which will crack on drying.

Pyroxyline, mainly the one that has been made at a high temperature, is liable to be decomposed. The first symptoms of this decomposition, are a strong acid smell, and a disintegration of the cotton, the fibers becoming short and broken. Then follows the reduction to a fine white powder, and finally to a glutinous mass, which on the addition of water degages abundant vapors of peroxid of nitrogen. The conditions most favorable to this decomposition, seem to be heat and compression. The contact of the air seems to be unfavorable to it, contrary to what has been advanced, for the soluble cotton will decompose much sooner in closely stoppered bottles, than in tin or paper boxes, or when wrapped up in paper. It should thus be packed rather loosely, mainly in the summer months, or in warm climates.

Acidity of the soluble cotton, resulting either from imperfect washing, or a commencement of decomposition, is very objectionable, as the acid decomposes the iodides and bromides used to sensitize, setting iodine free, and giving

a red color to the collodion. If the cotton has an acid smell, it should be washed with water, until all the acidity has been removed, which can be detected by means of litmus paper. It should then be pressed out in a towel, and allowed to dry. If you wish it to dry rapidly, wash the remaining water out with alcohol, and then press the alcohol out.

A mixture of ether and alcohol dissolves the soluble cotton, but neither of these liquids will dissolve it, when employed alone. Supposing the ether to be of a specific gravity, from 725 to 730, the alcohol from 92 to 95 per cent, and the cotton of good quality, the following formula will be found to be most generally admissible.

Ether	4 oz. fluid.
Alcohol	4 oz. fluid.
Cotton	from 30 to 60 grains.

Put the cotton into the bottle, pour on the alcohol, shake, then pour on the ether, and shake again, till all the cotton is dissolved. Or, the ether and alcohol can be first mixed together, and then the cotton added to it, but in this way it takes longer to effect the solution.

The proportion of cotton to be used in the collodion is variable, one cotton giving, when used in the same proportion, a great deal thicker collodion than another. This, as we have seen already, is owing to the temperature

of the nitro-sulphuric acid, the cotton made at a high temperature giving a more fluid solution than the one made at a lower. The photographer can thus only judge of the quantity of cotton he has to use by coating a glass with the collodion made with it.

Cotton, possessing to an extreme degree the peculiarities resulting from having been made at a low temperature, is not suitable for photographic purposes. If it has these peculiarities only in a small degree, the plain collodion made with it can be corrected in three different ways. 1st,—By increasing the proportion of alcohol, using for this purpose alcohol of at least 95 per cent. 2nd,—By adding chloroform, in the proportion of one or two drachms to a pound. 3rd,—By decomposing it partially by the addition of *aqua ammonia*. The ammonia, like all other alkalies, decomposes the pyroxyline, and makes the solution fluid, so that it yields a beautiful, even, and porous film. The same effect is produced in iodized collodion, by the alkaline iodides and bromides, but to a smaller extent. The way of proceeding is to add five or six drops of strong ammonia to about a pint of collodion, testing it every day, and when it has come to the proper condition, neutralizing the remaining ammonia with hydrobromic acid. The practitioner should be cautious against using too much ammonia, or letting it act too long a time, for the film would become so rotten that

a stream of water would wash it off the glass, or, if the decomposition was not quite carried to that point, it would, after drying, be cracked all over, just as if the cotton had been partly decomposed in the acid, or as if too much water was present in the collodion. If, however, the effect of the ammonia was carried too far, the remedy would be to mix the rotten collodion with some newly made, till a mixture is obtained which has the desired properties.

Independently of the quality of the pyroxyline, the resulting solutions differ in character, according to the relative proportions of the solvents employed. When the ether is used in a large quantity, the collodion film spreads with difficulty over the plate, owing to the rapid evaporation. The film is very tough, coherent and contractile, so that it will often separate from the sides of the glass, if not handled and dried with precaution. It is also devoid of porosity. When, to such a collodion, alcohol is added in suitable proportions, all these inconveniences are removed, and it will spread with more regularity, and give an even, soft, and easily torn film, which possesses great adherence to the plate, and has no tendency to contract or peel in drying.

We see thus that the character of a plain collodion, with an excess of ether, is similar to the one made with the ordinary quantity of ether. and a cotton produced at a low temper-

ature. On the other hand, the use of a large quantity of alcohol is equivalent to the use of a cotton made at a high temperature. The knowledge of these facts enables us to employ, with success, cotton which otherwise we would, perhaps, condemn as useless. Thus, when a collodion made with equal quantities of the solvents, gives a wavy and contractile film, an addition of strong alcohol may improve it and bring it to the proper condition. If, on the contrary, the film was too short and rotten, a larger quantity of ether would give more toughness and cohesion to it.

The purity or strength of the solvents has, also, an influence on the state of the film. Alcohol and ether, of a high specific gravity, contain much water, and their use should be avoided. An excess of water in the collodion is very injurious. It thickens it and makes it flow with difficulty, and it makes the film sometimes so rotten that it washes off the plate. The water is, also, one of the causes of the reticulated appearance which the film presents in drying. It seems to be cracked all over, and made up of a kind of network which deprives the impression of sharpness. This effect is more to be feared in cold than in warm weather, so that in winter more care has to be taken to procure good samples of ether and alcohol than at any other season of the year.

Collodion prepared in all the conditions

which insure success, will, in being properly poured on a clean glass plate, present the following peculiarities. 1st. It will not run off the edges of the glass; if it does, the quantity of cotton is too small. 2nd. It will give, when dry, a transparent film free from cracks. If the film is semi-opaque or cracked, it indicates either that the cotton is of bad quality, or that the collodion contains an excess of water. The cotton which gives a semi-opaque and cracked film, is the one made with weak acids at a high temperature, and which is partly decomposed by the acids. 3rd. It will flow evenly, giving a film without waves. If not, the cotton is of the glutinous variety, or in too large a quantity, and one of the remedies given above will have to be applied. 4th. It must be adherent to the glass, and tough enough to bear a slight rubbing when it has set.

A plain collodion being obtained, which possesses the qualities just enumerated, the next thing is to charge it with a certain quantity of iodide and bromide.

Collodion sensitized with iodide alone, will often give images in which the high lights are very dense by transmitted light, and the middle tints deficient by reflected light. Such collodion is made with cotton possessing the intense qualities to an extreme degree, and is more suitable for negatives than for positives. If to such a collodion a small quantity of bromide is added, the high lights will become

less dense by transmission, and the relation between whites and blacks more harmonious; at the same time, the duration of the exposure in the camera will be shortened. This last fact is unaccountable, and seems to be entirely contrary to what might be expected. It is known to a certainty that iodide of silver in presence of nitrate of silver, is more sensitive to the combined action of the light, and a developing agent, than bromide of silver in the same condition. A paper prepared with iodide of silver, will, under the influence of a developer, bring out an image with a shorter exposure to the light than one prepared with bromide of silver. Why then is bromo-iodized collodion not less sensitive than iodized collodion, instead of being more so?

The effect of bromide is thus to reduce intensity or contrast, and increase sensitiveness. With collodion, which does not, from the quality of the cotton, give very contrasted images, it should be omitted, or only used in small quantity.

The bromide of silver is more sensitive to colored light than the iodide of silver. In the case of the iodide of silver, the action ceases in the blue ray of the spectrum, but with the bromide it reaches into the green. In both cases, however, the most intense chemical action resides in the indigo and violet, and goes on decreasing in measure as the green is approached. The sensitiveness of

the bromide of silver to the green ray, has induced the supposition that a collodion, sensitized with iodide and bromide, was best suited to landscape photography, inasmuch as it would reproduce the green foliage. This belief is unfounded, however. The effect produced by the green ray on the bromide of silver, is very small when compared to the effect produced by the indigo, violet and actinic invisible rays. Even if it were possible to obtain suitable collodion, sensitized with bromide alone, the more actinic rays would have arrived at the maximum of their action, before the green tints would have had time to produce an impression on the sensitive surface. When bromide is used in connection with iodide, which is insensible to the green ray, the effect of the green tints would be still less. That bromide is useful in landscape photography, cannot, however, be denied; but this results from the property it possesses to harmonize more the relation between light and shade, or, as we have stated above, to reduce contrast. What produces the superiority of bromo-iodized collodion, for landscape photography, is not the sensitiveness of bromo-iodide of silver to green light, but its superior sensitiveness to feeble emanations of white light, such as those which are scattered from even the darkest green foliage, and by which iodide of silver fails to be impressed.

The iodides and bromides used to sensitize collodion are the following :

Iodide and bromide of potassium.
Iodide and bromide of ammonium.
Iodide and bromide of cadmium.
Iodide and bromide of magnesium.
Iodide and bromide of zinc.

A great difference of opinion exists as to which iodide or bromide is the most useful to sensitize collodion. Some are said to give superior results, others to be more sensitive. A series of experiments, undertaken to test the value of these assertions, proved to us, however, that the bases of the iodides and bromides, generally used, have no direct effect on the beauty of the results, or on the sensitiveness, if they are used in strictly the same conditions, and in such proportions as to bring into the collodion the same quantity of iodine and bromine. The iodide of iron makes exception, as we will see further.

Amongst the compounds used as sensitizers, some are readily soluble in the collodion. These are the iodides of ammonium, cadmium, magnesium and zinc, and the bromides of cadmium, magnesium and zinc. Others, the iodide of potassium and bromides of potassium and ammonium, are nearly insoluble in collodion, made with concentrated solvents. When required for use, they should be dissolved in a small quantity of water, and added to the collodion. If the solvents are not very con-

centrated, the salts may be first dissolved in a part of the alcohol used to make the plain collodion, and then added to the solution of cotton. This last way of operating is preferable to the other, as it does not introduce any more water into the collodion.

Each one of the salts used to sensitize collodion does not contain the same quantity of iodine or bromine; so that one salt will produce a smaller amount of iodide or bromide of silver in the film than another. The following table gives the proportions of iodine and bromine present in each one of the iodides and bromides generally used:

1000 parts	Iodide	of	magnesium	contain	914	parts	Iodine.
"	"	"	ammonium	"	876	"	"
"	"	"	zinc	"	796	"	"
"	"	"	potassium	"	764	"	"
"	"	"	cadmium	"	694	"	"
"	"	Bromide	magnesium	"	870	"	Bromine.
"	"	"	ammonium	"	816	"	"
"	"	"	zinc	"	714	"	"
"	"	"	potassium	"	672	"	"
"	"	"	cadmium	"	588	"	"

Collodion sensitized with the iodides of ammonium, potassium, magnesium and zinc becomes red after a short time, and loses sensitiveness. This coloration is due to the oxidation of the ether and to the decomposition of the pyroxyline.

Ether exposed to the contact of the air, and to the influence of light, absorbs oxygen, and generates acetic acid. This acetic acid, combining with the bases of the iodide, forms an acetate, and sets iodine free, which dissolves in

the liquid, and colors it yellow, orange or red, according to the degree of decomposition which has taken place.

The decomposition of the pyroxyline is produced by the alkaline iodides, such as those of ammonium, potassium and sodium. The bases of these iodides act on the pyroxyline, setting peroxid of nitrogen free, which, in its turn, acts on the iodide, and liberates iodine. The effect of the alkaline iodides on the pyroxyline is the same as that produced by ammonia and other alkalies. The collodion becomes fluid and gives a porous film, and when the effect goes farther, becomes rotten. The iodides of cadmium, zinc and magnesium, on the contrary, produce a thickening of the collodion, immediately after sensitizing, but have not the same decomposing influence on the pyroxyline.

The decomposition of the collodion is favored by heat and light. According to Mr. Tiffereau, a collodion which has been exposed to the sun's rays for a short time, becomes more fluid, and acquires an exalted sensitiveness; but this sensitiveness is entirely lost soon afterwards.

We have seen that a pyroxyline, made at a high temperature and with weak acids, decomposes spontaneously much quicker than one made with strong acids. When such pyroxyline is used in the manufacture of collodion, it communicates its decomposing properties to it. It should thus be used only with good neutral

ether and alcohol, and the collodion sensitized with the compound least liable to decompose.

The most stable amongst the iodides is the iodide of cadmium. Collodion prepared with pure materials, and sensitized with iodide of cadmium, will keep for months without discoloring.

Bromides are more stable than iodides; a bromo-iodized collodion will keep longer than one which is sensitized with iodide alone.

The presence of much free iodine in collodion affects its sensitiveness. The red color can be removed, and the sensitiveness partly restored by dipping into it a strip of zinc, or a stick of metallic cadmium. The zinc or cadmium will take up the free iodine, and form iodide of zinc or of cadmium. The metal should be removed as soon as the collodion is yellow or orange.

A small quantity of free iodine in the collodion, enough to tint it yellow or orange, is not objectionable, as it does not interfere with the sensitiveness. A well iodized collodion, which has slightly turned red, can even be used without much loss of sensitiveness, in connection with a neutral or very slightly acid silver-solution of the full strength. In such cases, there is no necessity for removing the color.

Independently of the state of the silver solution and developing fluid, the sensitiveness of the film of collodio-iodide of silver depends, 1st, On the absence of certain retard-

ing compounds, such as iodates, carbonates, xanthates, etc. introduced in the collodion by sensitizing compounds, prepared in an improper or careless way.—*See Chemistry of Iodide of Potassium.*

2nd. On the absence of much free iodine in the collodion.

3rd. On the presence of bromide in the collodion. When a collodion gives impressions in which too much contrast exists between light and shades, an addition of a small quantity of bromide will lessen the contrast, and at the same time cause the film to be impressed, by a shorter exposure in the camera.

4th. On the purity of the solvents. Ether which has been kept some time is acid to test paper, and liberates iodine in the collodion. Alcohol often contains fusel oil, which has a retarding influence.

5th. On the relative proportions of the solvents. An excess of alcohol in the collodion, producing a soft and porous film, is favorable to sensitiveness; an excess of ether, making the film tough and penetratable with difficulty, is unfavorable to it.

6th. On the quality of the pyroxyline. A pyroxyline which gives a film corresponding to the one produced by the use of much alcohol, gives a more rapid collodion than one giving a tough and contractile film.

7th. On the decomposition of the collodion. As we have seen, the presence of much free

iodine in the collodion is unfavorable to sensitiveness. A loose state of the film on the contrary is favorable. If a tough and contractile collodion is iodized with an alkaline iodide, (iodide of potassium, sodium or ammonium,) the decomposition which ensues will liberate iodine, and make the film softer and more porous; and the retarding influence of the free iodine will be overcome by the increased sensitiveness produced by the softening of the film. If now the liberation of the iodine be checked by using the iodide or bromide of cadmium in connection with the alkaline iodide, the result will be a collodion which will remain colorless, or become only yellow, and which will, after the alkaline iodide shall have acted sufficiently on the pyroxyline, give a soft and porous film. In this case, decomposition will have the effect of increasing the sensitiveness of the collodion.

8th. Use of iodide of iron. Iodide of iron, used in small quantity in the collodion, will give it a great sensitiveness. This is owing to the double decomposition which takes place between the iodide of iron and nitrate of silver and by which are produced iodide of silver, and nitrate of iron, which is a developing agent.

We have seen already, that with collodion sensitized with the cadmium compounds, an addition of a few drops of tincture of iodine, or hydrobromic acid, is a valuable improve-

ment, especially when a neutral or a slightly acid bath is used. The addition of iodine, or better, of hydrobromic acid is necessary when collodion is used, manufactured with ether or alcohol, which has been concentrated by means of quick-lime. In this case, hydrobromic acid will have to be added till the collodion takes a yellow color, which effect only takes place a few hours after the addition.

Tincture of Iodine.—Tincture of iodine is a solution of iodine in alcohol. When the strongest alcohol is used, ten parts in weight will dissolve one part of iodine. It is not necessary to have it as strong for photographic purposes. It may be prepared by dissolving one drachm of iodine in four ounces of alcohol, 95 per cent.

Hydrobromic acid.—The compound called by photographers *hydrobromic acid*, and which is a mixture of hydrobromic acid, hydrobromic ether, etc., is prepared in the following manner: Take one or two ounces of alcohol, 90 per cent, and add to it a quantity of bromine, sufficient to give it a red color. The next day it will have become colorless; then add bromine again, and if the color is again removed, continue adding bromine until the liquid stays yellow or red. When this arrives all the alcohol has been transformed. What remains to be done is to remove the color by adding a few more drops of alcohol. The hydrobromic acid acts on the

collodion by liberating iodine. It is best to add it only to a small quantity at a time, such as is required for use the next day, because collodion to which it has been added loses too much of its sensitiveness when it is kept some time.

The film of collodio-iodide of silver, which is formed on the collodionized plate, by dipping it into the silver solution, varies in color and appearance according to the quantity of iodide used. A small quantity of iodide gives it a blueish transparent color. A larger quantity makes it white and translucid. A larger quantity still makes it creamy opaque. When the collodion contains so much iodide, that the iodide of silver formed cannot be retained in its pores, it is said to be *over iodized*, If such collodion is poured on to a glass, and dipped into the silver solution, flakes of iodide of silver will come off and float in the bath. The image will, also, be entirely on the surface, and may be rubbed off, without the film of pyroxyline being injured.

The white and translucid film is the most favorable. Blueish transparent films can be used with weak neutral silver solutions, but the collodion should not be colored deeper than yellow. Creamy opaque films yield rough pictures, deficient in middle tints, except when acid silver solutions are used, and in this case the sensitiveness is impaired. Films of moderate thickness, iodized so as to appear white

and semi-opaque, give the best gradation of tone, and are uninjured by a moderate acidity of the silver solution.

The quantity of bromide, to be used in the collodion, depends on the character of the pyroxyline. This can only be ascertained by trial. The plan we think the best is to make a bromo-iodized collodion, containing a rather large quantity of bromide, and to add it to the collodion found to be faulty until the desired effect is obtained.

IODIZED COLLODION.

Plain collodion	8 oz. fluid
Iodide of ammonium	35 grains.
Iodide of cadmium	10 grains.

The plain collodion used in this formula should be of the kind which gives a rather tough film, as the large proportion of iodide of ammonium it contains will soon act on the pyroxyline, and soften the film. If the contrast it gives between whites and blacks is too great, mix it with a certain quantity of the following bromo-iodized collodion:

Plain collodion	8 oz. fluid.
Iodide of ammonium	35 grains.
Bromide of cadmium	40 grains.

If instead of the iodide of ammonium you wish to use the iodide of potassium, proceed as follows: 1st, dissolve 40 grains of iodide of potassium in the smallest possible quantity of water; 2nd, pour this into 4 ounces of alcohol, 92 per cent. and shake; 3d, add to this alcohol 4 ounces of sulphuric ether, shake and let settle; 4th, draw off the clear

part by means of a syphon, and add the iodide or bromide of cadmium; 5th, dissolve into the liquid the necessary quantity of pyroxyline.

Should you wish to substitute any other iodide or bromide to those given above, it can be done by taking into account the quantity of iodine and bromine each one contains. The following table will facilitate this:—

35 grains of iodide of ammonium contain the same amount of iodine, as
40 grains iodide of potassium,
44 " iodide of cadmium,
33½ " iodide of magnesium,
38½ " iodide of zinc.

49 grains bromide of cadmium contain the same amount of bromine, as
29 grains bromide of ammonium,
35 " bromide of potassium,
27 " bromide of magnesium,
33 " bromide of zinc.

Instead of using the sensitizing salts in a dry state, it is sometimes more convenient to make an iodizing solution, and to add it to the collodion till it gives a white and semi-opaque film. Any of the iodides or bromides can be used for that purpose. The following is used in the manufacture of Charles Waldack's Positive and Negative Collodion:

IODIZING SOLUTION.

Iodide of ammonium.....4 drachms.
Iodide of cadmium.....4 drachms.
Alcohol (95 per cent).....3 oz. fluid.

BROMIZING SOLUTION.

Bromide of cadmium.....1 oz.
Alcohol (95 per cent).....3 oz. fluid

From 4 to 5 drachms of the iodizing solution are sufficient to give to 8 oz. of collodion the degree of opacity wanted. The quantity of bromizing solution to be added depends, as we have seen already, on the contrast existing between the lights and shades. This iodizing solution, containing less alkaline iodide than is prescribed in the first formula, can be used with a plain collodion, giving a rather short and soft film.

The iodide and bromide most suitable to sensitize collodion, which gives a soft film, are the iodide and bromide of cadmium. The iodides and bromides of potassium and of ammonium should not be used, as, by their powerful action on the pyroxyline, they would soon make the collodion rotten. They may be used with great advantage to sensitize tough collodion, which they will bring in a short time to a porous state, very favorable to sensitiveness and intensity.

We will now give some formulas of collodion most used. None of these formulas will hold good under all circumstances. The operator will have to use his own judgement in compounding them, and if he has made himself well acquainted with the different influences which determine the character of the collodion, it will be an easy task for him to obtain any effect he desires.

No. 1.—Plain collodion..... 8 oz.
Iodide of ammonium.....32 grains.
Bromide of cadmium.....10 grains.

Dissolve directly the iodide of ammonium, and the bromide of cadmium, in the plain collodion, and allow it to settle. The next day it is fit for use. When pure materials are used, this collodion will be of a straw color the day after it has been made, and it will keep for a long time, in good condition, the bromide of cadmium counteracting the decomposing influence of the iodide of ammonium. The film should not be too tough, nor too soft, but should possess intermediate qualities. The cotton should be of the intense kind.

No. 2.—Plain collodion ..... 8 oz.
Iodide of potassium ..... 36 grains.
Bromide of cadmium ..... 10 grains.

Put the iodide of potassium in an 8 oz. bottle, and dissolve it in as small a quantity of water as possible, then add the 8 oz. of collodion, and finally the bromide of cadmium. Or, better yet, modify the formula as follows: make your plain collodion with 2 oz. less alcohol, and in this alcohol dissolve your iodide of potassium, reduced to fine powder—

Plain collodion ..... 6 oz. fluid.
Iodide of potassium 36 grains (dissolved in 2 oz. alcohol.)
Bromide of cadmium ..... 10 grains.

No. 3.—Plain collodion ..... 8 oz. fluid
Iodide of cadmium ..... 50 grains.
Bromide of cadmium ..... 6 grains.

This collodion will keep for a very long time without decomposing. The plain collodion should be of the kind which gives a soft and porous film, for the cadmium sensitizers have

no decomposing action on the pyroxyline, but thicken the collodion, and make it more glutinous than it was before. Collodion which has been submitted to the decomposing action of the ammonia, will answer very well for this formula. A few drops of tincture of iodine, or hydrobromic acid, added to it will be found useful.

No. 4.—Plain collodion..... 8 oz. fluid.
Iodide of potassium.....40 grains.
Bromide of potassium.....10 grains.

Dissolve the iodide and bromide of potassium together in the smallest quantity of water possible, add the collodion, shake, and let settle. Or, better, make your plain collodion with 4 oz. ether, and 2 oz. alcohol, reserving the 2 other ounces alcohol to dissolve your iodide and bromide of potassium. You will have thus:

Plain collodion.....6 oz.
Iodide of potassium 40 grains, Bromide of potassium 10 grains } dissolved in 2 oz. alcohol.)

This collodion being sensitized with alkaline iodide and bromide will have to be made with cotton giving a tough film. After a period of about a week, the action of the alkaline salts on the pyroxyline will have brought it to the proper condition.

No. 5.—Plain collodion.....8 oz. fluid.
Iodide of potassium .....20 grains.
Iodide of cadmium..... .20 grains.
Bromide of ammonium.....10 grains.

Dissolve the iodide of potassium and the

bromide of ammonium in the smallest quantity of water possible, then add the collodion, and finally the iodide of cadmium, or dissolve the iodide of potassium and bromide of ammonium in part of the alcohol prescribed for the preparation of the plain collodion. This collodion will keep for a considerable time, the iodide of cadmium it contains giving durability to it. It should be made with cotton giving a rather tough film.

No. 6.—Plain collodion..... .8 oz. fluid.
Solution of bromo-iodide of silver, a sufficient quantity to give a white and semi-opaque film.

The solution of bromo-iodide of silver is prepared in the following way:

Dissolve 120 grains nitrate of silver in 2 ounces of water, and 80 grains bromide of potassium in 2 other ounces of water, and mix these two solutions together; the result will be a precipitate of bromide of silver and the formation of nitrate of potash, which will remain in solution. Let the precipitate settle and pour carefully the liquid off; then add some distilled water, shake, let settle, and pour the liquid off again. Repeat these washings three or four times in order to remove all the nitrate of potash. Then wash once or twice with alcohol in the same way as with water. Put the pure bromide of silver obtained in this way into a ten or twelve ounce bottle, and add it to one ounce of iodide of potassium reduced to a very fine powder, and

8 oz. fluid of alcohol, of ordinary strength. Shake from time to time till the alcohol has dissolved as much iodide of potassium as possible. The clear liquid is called a solution of bromo-iodide of silver.

When bromide of silver is dissolved in a solution of iodide of potassium, double decomposition takes place between the bromide of silver and a part of the iodide of potassium, so that bromide of potassium and iodide of silver are formed. The iodide of silver thus formed dissolves in the iodide and bromide of potassium. The so-called bromo-iodide of silver is, therefore, an alcoholic solution of iodide and bromide of potassium saturated with iodide of silver.

It must be observed, that the more water the alcohol contains the stronger the solution will be; so that, if prepared with 95 per cent. alcohol (containing 5 per cent. water) it will require a larger quantity to iodize collodion than when prepared with 90 per cent. (containing 10 per cent. water). It will thus be best to use 90 per cent. alcohol, or if stronger, to have it diluted with the required quantity of water.

Very rapid Collodion with Iodide of Iron.— We have seen already that iodide of iron mixed with the collodion gives it a high degree of sensitiveness. We will here describe the process of Alph. De Brebisson, which, in our

hands, has proved very successful, as far as rapidity of impression is concerned.

Plain collodion.....8 oz. fluid.
Alcoholic solution of iodide of silver in iodide of potassium enough to give a white and semi-opaque film.
Alcoholic solution of iodide of iron.....1 oz. fluid.

The plain collodion should be made with 5 oz. ether and 3 oz. alcohol.

The alcoholic solution of iodide of silver in iodide of potassium is made in the following way:

No. 1.—Distilled water.....2 oz. fluid
Nitrate of silver.....120 grains.

No. 2.—Distilled water.....2 oz. fluid.
Iodide of potassium.....120 grains.

Mix these two solutions together and wash the precipitate of iodide of silver which is formed in several waters, and finally in alcohol, just as is prescribed for the bromide of silver, page 55. Now pulverize very finely one ounce of iodide of potassium, add it to the iodide of silver, add also 8 oz. alcohol, 90 per cent. and shake. The clear liquid is an alcoholic solution of iodide of silver in iodide of potassium. The iodide of iron is prepared as follows:

Distilled water.....2½ oz. fluid.
Iron wire or tacks.....1 drachm.
Iodine.....3 drachms.

This combination gives, after two or three days, a liquid of a light green color. Take of it one drachm, to which you add three or four drops acetic acid and one ounce of alcohol.

This gives an alcoholic solution of iodide of iron, which keeps very well.

This collodion will have a red color, and will remain sensitive but a few days.

The solution of iodide of iron may be added to any other collodion and increase its sensitiveness, but it is always followed by the same results: total loss of sensitiveness after seven or eight days. Another effect of the iodide of iron is to make the collodion thick like a jelly.

The iodide of iron collodion cannot be recommended except in extreme cases, as the results it gives are inferior. The operator should also be cautious not to use it in his ordinary silver solution, as it would soon bring decomposition into it. The best is to have a silver solution apart, and to keep it exposed to the light when not in use.

If one of the collodions prepared by the above formula gives a creamy film, or one that is too transparent, bring it to that state of iodizing which is white or semi-opaque. The opacity of the collodion film depending, 1st, On the quantity of iodizing; 2d, On the quantity of cotton, it can be increased or decreased, in two different ways; 1st, By increasing or decreasing the quantity of iodizing; 2d, By increasing or decreasing the quantity of cotton. Thus, when the film is transparent and thin, add cotton to give it more opacity. When transparent, and of the required thickness, add iodizing. When

it is opaque and thin, dilute with plain collodion. When opaque and thick, dilute with alcohol and ether in suitable proportions.

CHAPTER VII.

The Silver Solution for Positives.

The materials which enter into the silver solution are the following: Crystalized or fused nitrate of silver, water, iodide of potassium and nitric acid.

Nitrate of Silver.—The nitrate of silver used should be the best that can be obtained. It is a false economy for operators to buy a cheap article, which is either adulterated or carelessly prepared.

Crystallized nitrate of silver is in the form of white crystalline plates. When dissolved in water it should be neutral to litmus paper. It is very important that it should be free from organic matter, with which that especially crystallized out of the acid mother liquors is often contaminated.—*See Chemistry of Nitrate of Silver.* When in this state it is not fit for use, unless it be heated in a porcelain evaporating dish or crucible, till it fuses, and the organic matter be decomposed.

Fused nitrate of silver (lunar caustic) is found in commerce in the form of white sticks.

When not adulterated with nitrate of potash, it can be used in photography. It contains a small quantity of nitrite of silver, which makes its solution alkaline to test paper; but this is not objectionable, as a drop of nitric acid transforms this nitrite into nitrate.

Water.—The water required to dissolve the nitrate of silver must be pure, free from organic matter and from salts. Distilled water will answer the best, or rain water which has been caught in an open jar and boiled. Also, clean melted ice and boiled soft spring water. Rain water which comes from roofs, must be rejected on account of the large quantity of organic matter it contains. The tests for pure water are the following: 1st, If a drop is put on a clean glass plate, and evaporated by a gentle heat, it leaves no residuum. 2nd, No precipitate or milkiness is produced, when a few drops of a solution of chloride of Barium or nitrate of Baryta are added to it. If the water becomes milky, or if a precipitate is deposited, it contains a sulphate, probably sulphate of lime. 3rd, Nitrate of silver produces no precipitate. If it did, it would be a proof the water contains either a chloride or a carbonate; a chloride, if the precipitate be soluble in ammonia; a carbonate, if insoluble in ammonia, and soluble in nitric acid. 4th, If a few crystals of nitrate of silver are added to it, and it is exposed to sunlight in a white bottle,

the liquid remains colorless. If it turns brown or black it contains organic matter.

Small quantities of chlorides, carbonates, or of organic matter, are not very objectionable in water to be used to make a silver solution. Their presence results in the loss of a small quantity of nitrate of silver; quantity generally too small to interfere with the strength of the solution.

Iodide of potassium.—Such as is used in iodizing collodion, answers for the silver-solution.

Nitric acid.—Use the chemical pure, or the ordinary; but let this be free from sulphuric acid, which would produce sulphate of silver in the solution.

The strength of the silver solutions generally made, is forty grains to the ounce. Twenty grain silver solutions are recommended by some to be used with slightly iodized collodion, such as gives a blue transparent film when dipped into the silver bath. We do not recommend such a combination, although it may sometimes give good results, but its use is more difficult, especially in the development of the impression.

The silver solution is prepared in the following way.

Neutral crystallized nitrate of silver	1 oz.
Water	12 oz. fluid.
Tincture of iodine	10 drops.

The silver is dissolved in the water, and

the tincture of iodine added to it. The iodine will precipitate in the form of iodide of silver, of which a part will be dissolved. Instead of tincture of iodine, you may use two grains of iodide of potassium, which will produce the same effect.

A solution of nitrate of silver dissolves iodide of silver to a certain extent. It is therefore necessary, previously, to saturate the nitrate solution with it. If no attention is paid to this, the iodide of silver, after having been produced in the film, would be partially dissolved. This is the reason why iodine or iodide of potassium has to be added, which, by double decomposition, changes into the iodide of silver.

If the silver solution has been made with water suspected to contain organic matter, it will be advisable to expose it to the sun-light for an hour or so. Light has no action on a solution of pure nitrate of silver in pure water, but if any organic matter is present, the solution will become brown, and a part of the silver will be reduced and precipitated in the state of a black powder. In the case where tincture of iodine is used, it is best to expose the solution to the sun-light before iodizing it. Iodine sets nitric acid free, and nitric acid counteracts the decomposition, so that the solution would have to be exposed much longer to the sun-light before all the organic matter be removed.

If iodide of potassium is used to iodize the silver-solution, one or two drops of chemically

pure nitric acid will have to be added. The formula will thus be as follows:

Neutral crystallized nitrate of silver.....1 oz.
Water.....12 oz. fluid.
Iodide of potassium.....2 grains.
Nitric acid.....1 or 2 drops.

The fused nitrate of silver is sometimes of a black color, owing to the decomposition of a small quantity of it during the fusion. In case it be used, the iodizing and nitric acid should only be added after the black powder has been separated by filtration. Filter through Swedish filtering paper, or, better yet, through cotton. Put a tuft of cotton into the neck of a funnel, pour on 10 or 12 drops of alcohol, remove the alcohol with water, and then pour your silver-solution into the funnel. It may, at first, not filter entirely clear, but it will soon do so. Before filtering the silver-solution, it is necessary to let it settle; if not, the precipitate would soon obstruct the filter.

In case nitrate of silver is used, which is acid, the solution should be first neutralized, and then treated in the ordinary way. An acid solution of nitrate of silver reddens the blue litmus paper. To neutralize it, make the following solution.

Sesqui-carbonate of soda (the one used for effervescent draughts).....½ oz.
Water.....4 oz. fluid.

Add of this a few drops at a time, shaking after each addition. The precipitate of carbonate of silver will redissolve as long as there

is any acid present, and when all the acid has been neutralized, the liquid will become turbid; it should then be filtered. The solution in this state is faintly alkaline, but this alkalinity is removed by the small quantity of nitric acid which is added to it, either directly or indirectly through the iodine.

Neutral and acid silver solutions.—Neutral solutions are those which contain neither free acids nor free oxides. They do not turn red the blue litmus paper, as do the acid solutions; nor do they turn blue the reddened litmus paper, as do the alkaline solutions.

The presence of free nitric acid injures the sensitiveness of the film of collodio-iodide of silver. A slightly acid bath, such as the one we have prescribed, is, however, preferable to a neutral one. If the sitting-time is a little longer, this disadvantage is amply compensated by a greater uniformity in working. A larger quantity of acid should be added only when the pictures obtained are foggy or covered with a veil, and the operator has no time to apply the remedy spoken of under head—Decomposition of the Silver Solution.

Decomposition of the Silver Solution.—A pure solution of nitrate of silver, in water, is not affected by light; but when it contains organic matter, it will, under the influence of light, be decomposed, till all the organic matter has been removed, and a corresponding quantity of silver has been precipitated. Such a solution,

when exposed to the sun's rays, will first turn brown, and will then become clear again by depositing a black powder, which is nothing but reduced silver.

If a solution of nitrate of silver contains organic matter, decomposition takes place very slowly as long as it is kept from the light; but if it is exposed for a short time to it, and then shielded from its influence, the decomposing action will be less energetic than if it had been allowed to remain, but it will go on with much greater rapidity than before.

As long as decomposition is going on in a silver solution, no good pictures can be obtained, the free nitrate of silver, which is on the film, being reduced all over the surface of the plate, and covering it with a veil of metallic silver. When this happens, the remedy is to neutralize the silver solution with carbonate of soda, filter it, and then expose it to the sun-light till it has deposited the reduced silver, and has cleared up again. The necessity for neutralizing results from the fact that the reduction of the nitrate of silver by the organic matter is a great deal slower in the presence of nitric acid.

From all that has been said on this question, we may deduct the following rules of action: 1st, Never expose the solution you are using to the action of the light, unless it be exposed long enough to allow all the organic matter to be removed. 2nd, If the

solution works foggy, neutralize it, expose it a sufficient length of time to the sunlight, filter it and acidify it again with one or two drops of nitric acid. If it is impossible for want of time to apply this remedy, add nitric acid, 4 or 5 drops at a time, till clear pictures are obtained. This counteracts the decomposition, but will not put the solution in good order, as the organic matter is not removed. It should then, on the first opportunity, be neutralized and exposed to the light.* Organic matter gains access into the bath through the collodion, atmospheric dust, unclean glass, etc.

Every time a plate coated with collodion is dipped into the bath, a portion of nitrate of silver is transformed into iodide and bromide of silver, and a portion of the silver solution is taken out; so that while the silver solution decreases in volume, it also decreases in strength. It will, therefore, be necessary to fill up the bath every day with a solution which

* When a silver solution contains a large quantity of nitric acid, it is objectionable to use carbonate of soda to neutralize it, as in this way a too large quantity of nitrate of soda gains access into it. Instead of carbonate of soda, use oxide of silver, and proceed in the following way: To two or three ounces of your silver solution, add a solution of caustic potash till all the oxide of silver is precipitated; an excess of potash will do no harm. Then wash the precipitate several times with clear, and finally with distilled water; pour the water off and add the oxide of silver to the silver solution, which will dissolve part of it. It can then be filtered, and the remaining oxide of silver can be used for another neutralization.

contains a quantity of nitrate of silver sufficient to restore it to its original strength. But that quantity of nitrate of silver depends altogether on the quantity of iodide and bromide contained in the collodion film, and is difficult to determine. As a general thing, it will answer to fill up a bath containing 40 grains to the ounce, with the following solution:

Water.....8 fluid ounces.
Nitrate of silver.....1 ounce.

It is recommended to add every night to the silver bath a quantity of the above named solution, corresponding in volume to the quantity that has been taken out. If you wait until you have to add a large quantity at a time, the condition of your bath will change too much.

We have not added to the solution used in filling up the bath any iodide of potassium, nor any nitric acid. The quantity of nitrate of silver added every day is too small to dissolve sensibly the collodion film, so that the iodide and bromide are useless in making the addition. In regard to the omission of nitric acid, it is to be observed that every plate, coated with yellow or red collodion, imparts acid to the bath, so that the supply of acid is always kept up, and will even sometimes increase to an excess.

When the operator has some uncertainty in regard to the strength of his silver solution,

there exists an easy way to estimate it with sufficient accuracy.

Take the best table salt you can get, put it in a crucible and warm it gradually till it is red hot. The salt (chloride of sodium) will first crackle and then fuse. When it is well in fusion, pour it out on a stone and put it in well stoppered bottles. The chloride of sodium in this state contains no water. Take of it 17 grains and dissolve it in 6 fluid ounces distilled water. This gives you a standard solution of which each drachm will precipitate one grain of nitrate of silver.

Supposing that with this solution you want to ascertain the actual strength of a bath which was originally 40 grains, you will have to proceed in the following way:

Measure exactly $\frac{1}{4}$ ounce (2 fluid drachms) of your silver solution and put it in a 4 or 5 ounce bottle.

Rinse your measure out with two or three drachms of distilled water and add it to the two drachms of the silver solution.

Acidify with two or three drops chemically pure nitric acid.

Add to it 6 drachms of the standard solution, shake or stir with a glass rod and let settle.

If the clear liquid is made milky by the addition of a few drops more of standard solu-

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* Since issuing the first edition, a useful little instrument, called the *Silver Indicator*, has been introduced to the trade by the Scovill Manufacturing Co.

tion, the bath is stronger than 6 grains to $\frac{1}{4}$ oz. or 24 grains to 1 ounce.

Add thus two drachms more, shake and let settle.

If the clear liquid is made milky again by a fresh addition of salt solution, add one drachm more, and continue in the same way till all the silver has been precipitated in the state of chloride. In supposing that this be done with nine drachms of the standard solution, the solution tested will be of nine grains to $\frac{1}{4}$ ounce, or 36 grains to the ounce.

The testing of a new silver solution can be done by means of an instrument called hydrometer, which is well known to most operators. A solution which has been used, and which contains nitrate of potash, ammonia, cadmium, etc., cannot have its strength in nitrate of silver determined by means of the hydrometer, as all these salts add to the specific gravity.

CHAPTER VIII.

Developing Solution.

The materials used in the developing solution are the following:

Protosulphate of iron.	Water.
Acetic acid, No. 8.	Nitric acid.
Alcohol.	Nitrate of potash.
Nitrate of silver.	

Protosulphate of Iron.—This salt is known in the trade by the names of copperas or green vitriol. The common sulphate of iron requires recrystalizing in order to render it sufficiently pure for photographic purposes.

Water.—Distilled water, filtered rain, spring and river water can be used. It does not require to be as pure as for the silver solution, but it should not contain any chlorides, which would transform the nitrate of silver in insoluble chloride.—*See Tests for Chlorides in Chemistry of Chlorine.*

Acetic Acid, No. 8.—This acid, as sold by stock dealers and druggists, is generally pure. It contains sometimes sulphuric, sulphurous or hydrochloric acids, which can be detected, the first by nitrate of baryta, the two others by nitrate of silver. Acetic acid which has a smell of tar should not be used.

Nitric Acid.—The nitric acid used in the developing solution should be free from hydrochloric acid, which, like the chlorides, would transform the silver in insoluble chloride. The chemically pure nitric acid should thus be used, or if it cannot be procured, the hydrochloric acid, contained in the common nitric, should be precipitated as chloride of silver, by adding to it some of the silver solution. To that effect proceed just like in all other cases of precipitation. Add a few drops, shake and let settle, then add a few more, and so on till no more precipitate is formed. Some

samples of nitric acid, of a red color, contain a large quantity of hydrochloric acid, and it would be wasting nitrate of silver to attempt to bring them to a state fit for use.

Alcohol.—Alcohol 90 per cent will answer the purpose.

Nitrate of Silver.—Use the same as for making the silver solution.

Nitrate of Potash.—None but the refined nitre will answer, as the common nitre contains chloride of potassium.

FORMULA PRODUCING DEAD WHITES.

No. 1.—Protosulphate of iron,	.....	3 oz.
Water,	.....	40 oz. fluid.
Acetic acid, No. 8,	.....	4 oz. fluid.
Alcohol,	.....	3 oz. fluid.

Reduce the sulphate of iron to powder in a clean mortar, put it with the other ingredients in a bottle, shake till all is dissolved, and filter carefully through a tuft of cotton.

The strength of this solution is calculated for an ordinary temperature. In warm weather, when the development proceeds too rapidly, it may be diluted with an equal bulk of water, and two or three ounces more acetic acid added to it, or the proportion of protosulphate of iron may be lessened.

The effect of the alcohol and acetic acid is to make the development uniform, by causing the solution to flow evenly on the plate. The acetic acid, also, whitens the lights, and makes the shades brighter, and it cannot be omitted, or the image will not be clear.

The relative proportion of the ingredients used in the developing solution may be changed according to circumstances. If the development proceeds too rapidly or too slowly, decrease or increase the quantity of sulphate of iron. If the developer does not flow evenly over the plate, add more alcohol. If the picture obtained is not bright and clear, supposing the collodion and silver solution to be in good order, increase the quantity of acetic acid.

The developing solution given above, and all those in which the same compounds, and no other, enter, will, in the course of few days, take a reddish color, and in that state will work more evenly.

DIFFERENT FORMULAS FOR DEVELOPING SOLUTIONS.

No. 2.---Water.....1 quart.
Protosulphate of iron,.....1 oz.
Acetic acid, No. 8,.....1 oz.
Alcohol,.....1 oz.
Nitrate of Potash,.....2 drachms.
Silver Solution.....2 fluid drachms.

No. 3.---Protosulphate of iron,..... 3 oz.
Acetic acid, No. 8,..... 3 oz.
Alcohol,..... 4 oz.
Nitrate of silver,.....20 grains.
Sal Prunella, or Refined Nitre..... ½ oz.
Water,.....40 oz.

No. 4.---Water,.....10 fluid oz.
Protosulphate of iron,..... 1 "
Acetic acid, No. 8,..... 1 "
Alcohol,..... 1 "
Nitrate of silver,.....20 grains.
Nitrate of potash,.....120 "

No. 5.---Water,.....12 fluid oz.
Protosulphate of iron,..... ½ oz.

Acetic acid, No. 8,	1	oz. fluid.
Nitric acid,	2	dr'ms "
Nitrate of silver,	20	grains.
Nitrate of potash,	150	"

No. 6.---Water,	48	fluid oz.
Protosulphate of iron,	2	oz.
Nitric acid,	1	drachm.
Acetic acid, No. 8,	2	"

All these developing solutions give more or less metallic whites, and develop slower than the first one given. They will, also, require a little longer exposure in the camera, owing to the retarding influence of the nitric acid they contain.*

Wherever nitric acid is used in the formulas given above, care should be taken to add it only after the sulphate of iron has been mixed with the water. The effect of nitric acid on protosulphate of iron is to oxidize and transform it in persulphate of iron, which is not a developing agent.

CHAPTER IX.

The Fixing Solution.

The materials used as fixing agents are the cyanide of potassium and the hyposulphite of soda.

The fused cyanide of potassium, although it

* It is to be remarked here that in some of these solutions the nitric acid is introduced through the decomposition of the nitrate of silver by the sulphate of iron.

contains a great deal of carbonate of potash, is suitable. One drachm of this, dissolved in four ounces of water, will give a solution of the proper strength.

If hyposulphite of soda is used, six ounces should be dissolved in a pint of water. The hyposulphite solution should not be used more than once, or it will give a grey tinge to the whites of the image. The cyanide of potassium is generally preferred, because its use is less costly, and it does not make the whites grayish. Its solution can be used as long as it retains its solvent power.

The operator must be very cautious in using the cyanide of potassium, as it is a deadly poison. Its contact with wounds and sores on the hands should be avoided. Its smell, or rather the gas that emanates from it, when in contact with the air, produces violent headache, and irritation of the throat. We may here remark that the best antidote against the cyanide is the protosulphate of iron. The developing solution, which is always on hand, can be used immediately, in case of accident; or, better yet, one drachm of protosulphate of iron, dissolved in half a tumbler of water.

CHAPTER X.

Cleaning the Plate.

The surfaces used for the production of positive pictures are, as we have seen already, glass, melainotype plates, and japanned paper.

In the choice of the glass great care should be taken; it should be perfectly flat, without scratches, and quite free from scoria and air-bubbles. The polished plate glass answers the best, but is found generally too expensive, and the best kinds of window glass are used in its place. Common window glass is not suitable on account of the many air-bubbles, the unevenness, and the difficulty of cleaning it.

Before proceeding to clean the glass, the sharp edges should be filed off, to prevent the fingers from being cut, and the collodion film from separating from the sides. It is then to be immersed in a solution of one part of nitric or sulphuric acid in four or five parts of water, where it should be left for several hours. This solution corroding the skin, the glass should be removed out of it with a glass rod, or a piece of wood, after which it should be well rinsed with clean water, and wiped dry with a clean towel. The towel used for this purpose should be used for no other, and should not be washed with soap, but with a weak solution of carbonate of soda, and then carefully rinsed. Instead of wiping the glass dry with a towel,

it can be set to dry on a sheet of bibilous paper, or on two nails driven in the wall.

The operator must be careful not to set it while wet in a dirty place, as in virtue of the laws of capillarity, all the dust it touches will settle on its surface. The washing of the glass is very important, and should be carefully attended to, as the success of all the subsequent operations depends upon it. A glass which is well washed is easy to clean, but any amount of rubbing will not clean one which is not well washed.

When a washed glass is breathed upon, the moisture settles upon it in an irregular manner, affecting the form of lines in the direction it has been rubbed dry. If it were used in this state, these lines would, in all probability, interfere with the action of the developing fluid, and be reproduced on the picture.

The following operation is designed to produce a surface on which the moisture of the breath will condense uniformly. For this, prepare a mixture of rottonstone or polishing powder, and good pure alcohol. Put a small quantity of this mixture upon the glass, and rub it all over it for half a minute with a piece of canton flannel; then, before the alcohol has had time to dry, change your flannel for a clean piece, and continue the rubbing for a few moments longer. Finally, finish gently with a clean piece of buckskin.

In rubbing let your motion be circular, and do not let the powder dry on the plate, but wipe the plate dry with the second piece of flannel.

The glass has in this way to be cleaned on both sides, the finishing with buckskin on the side which is not used being dispensed with. The rottenstone on the edges should be well wiped off, and any particles of powder or filaments of cotton removed by means of a soft camel-hair brush.

While cleaning the glass, it may be held in a wooden vice, or in any of the plate holders sold for that purpose; or it may be simply laid on a clean piece of paper.

All glasses, after they have been used, should be put into the acidulated water, just like the new ones. Those which have been varnished should be allowed to remain in it till the film of varnish scales off.

The melainotype plates are less troublesome than the glass. When new they do not want any cleaning; simply brushing off with a soft hair brush, to remove any particles of dust, is all that is required, unless the plate has been handled and touched on the surface with the fingers. In this case, put on it a few drops of alcohol and rub dry with a piece of flannel. No rottenstone or scouring material is required, as the surface of the plate will not bear this. But very light pressure is needed in cleaning.

If an unsatisfactory picture has been made on the plate, rub it off when it is yet wet,

wash with clean water, and wipe with a silk handkerchief or a piece of canton flannel; it is then again ready for use. If the picture is dry rub it off with a little alcohol, and then go through with the aforesaid process of washing and wiping.

When the plate has been varnished, the varnish must be dissolved with alcohol and ether, using several pieces of clean flannel till the varnish has been all taken off.

Care has to be taken not to scratch the melainotype plates in cleaning them. It should be well understood that they do not require polishing. The object in cleaning them is only to remove foreign matter.

The Niello paper passes through the same process of cleaning as the melainotype plate.

CHAPTER XI.

Formation of the Film of Collodio-Iodide of Silver.

Having cleaned the glass the next operation is coating it with the iodized collodion. This part of the manipulation should be properly performed, as much depends on the evenness of the film. Grasp the plate firmly between the thumb and forefinger, holding it at the lower left hand corner, and after having dusted it off with a camel-hair brush, hold it as nearly level as possible, and pour a sufficient quan-

tity of collodion in the middle, then incline it down, so as to cause the collodion to flow toward the corner by which it is held, from thence toward the upper left hand corner, then toward the upper right, and finally down to the lower right, allowing the excess of liquid to pass back into the bottle. It is best now to hold the plate in an oblique position, moving it slowly back and forth, so as to cause the collodion to flow together in one smooth surface. Should you neglect this, you will invariably have lines running diagonally across the plate. The difficulty of obtaining a smooth surface depends greatly on the collodion itself. The thicker it is, the more dexterity will have to be used in coating the plate. If lines should be formed, notwithstanding the proper care has been taken to avoid them, the fault lays with the collodion, and it should be diluted with ether and alcohol, or thinned by one of the means we have described.

The bottle which contains the collodion should be wiped at the mouth before flowing each plate, as small particles of dried collodion, hanging at the mouth of the bottle, will often be loosened in pouring from it, and, settling on the film, will cause a spot on the picture. When large plates are flowed, it is advisable to pour the excess of collodion, which runs from the plate, into another bottle, in order not to stir up the deposit, which is often on

the bottom. If the collodion which has been used has become too thick, it will have to be thinned with a little ether.

The next operation is to immerse the collodionized plate into the silver solution. This should not be done before the film is perfectly *set*, that is, when it is so dry it receives the impression of the finger at its lower end, without sticking to it. If the plate were immersed too soon, lines would appear at the end which had been dipped first. The time the film requires to set is dependent on the temperature and on the quantity of ether and cotton which is in the collodion. It will take from half a minute to two minutes.

The baths holding the silver solution are made either of gutta percha, stone ware, glass, or vulcanised rubber. The gutta percha baths, not being made out of one piece, soon get disjoined and leak. The gutta percha seems, also, to decompose slowly the silver solution. The use of vulcanised rubber for baths we think objectionable on account of the sulphur it contains. The photographic ware baths (G. Mathiot's patent) are excellent, and hold the solution better than any other kind except those in glass. They are generally made in the overflowing style, and are the cheapest in the market. They should previously be filled with water, to see if they are not cracked. The stoneware baths, improperly called porcelain, are, after long use, more or

less penetrated by the silver solution; they are valuable, however, on account of the facility with which they are cleaned, and the small quantity of solution they require. The glass baths are, of all, the least objectionable, but they are heavy, and require a large quantity of solution; if they could be made lighter, and in the overflowing style or pattern, they would be the great desideratum.

The film being *set*, place the plate carefully on the dipper and lower it gradually without stopping. Any check of the plate, while being put into the bath, will cause an horizontal line across the surface. The plate must be left in the bath a time sufficiently long to allow all the iodide and bromide contained in the collodion film to be transformed into iodide and bromide of silver. If taken out as soon as the greasy appearance, caused by the solution of the alcohol and ether, is gone, as is recommended by some operators, it will appear when it is removed from the tablet to be developed a great deal more opaque than at the time it was taken out of the silver solution. This is a conclusive proof that all the iodide and bromide was not transformed into iodide or bromide of silver during the immersion in the bath, and that the transformation was continued after the plate was removed out of it, at the expense of the nitrate of silver that was on the surface of the film. This nitrate of silver on the film is necessary, and required in the process of devel-

oping the impression; so that removing a plate out of the silver solution too soon weakens the nitrate of silver on its surface, and is the same as using a bath that is too weak; in such a case the necessary relation between collodion and the silver bath does not exist, and no satisfactory result can be expected.

It is sometimes the case that irregular lines, most visible by transmission, are produced on the end of the plate which has been dipped first. This occurs when the collodion has not been well set. These lines occur mainly in weak solutions, and with collodion which has been made with an excess of alcohol of insufficient strength.

The length of time the plate has to remain in the solution depends: 1st, On the porosity of the film; 2nd, On the quantity of sensitizing; 3rd, On the strength of the bath; 4th, On the temperature. Generally from two to four minutes' immersion will answer the purpose.

The film, sometimes, shows a disposition to get loose from the plate, while being taken out of the bath, or in the following operations. This want of adherance may be produced by different causes: 1st, Want of adherance of the film to the glass resulting either from the character of the cotton, or the excess of ether in the collodion; 2nd, Imperfect setting; 3rd, Excess of acidity of the silver solution. These three causes suggest the remedies to be applied.

As we have already mentioned, on page 62, the silver solution has to be saturated with iodide of silver to prevent the iodide of silver in the collodion film being removed. Now, the power of nitrate of silver to dissolve the iodide, depending on the strength of the solution, it is easy to understand that a bath, in getting weaker by use, will lose, to some extent, its power to keep the iodide of silver in solution; it will then assume the form of needle-like crystals, which will float in the solution, and deposit on the sides of the dish. When a collodionized plate is coated in such a solution, these crystals will also deposit on the film, which will sometimes, on removal from the bath, appear as if it had been sprinkled with sand. In the subsequent operations this crystalline deposit is washed off or dissolved, leaving the surface pierced by a multitude of small holes, commonly known as pinholes.

It is not only the weakening of the bath by use which will produce this effect. It has been ascertained lately, by Mr. Vogel, that iodide of silver is less soluble in nitrate of silver when warm than when cold; so that a bath, which in cold weather will be free from the defect mentioned above, will be subject to it during hot days. This also explains the fact so often complained of, that baths, working well in the morning, produce pinholes later in the day.

The remedy for this difficulty is suggested by what we have just said. A bath should not be *saturated* with iodide of silver, especially when there is but a small volume of it, or when it is to be used in a warm room.

When the bath is regularly filled up with a stronger uniodized solution of nitrate of silver, as recommended on page 67, it will very seldom get to such a state as to produce pinholes. When this accident does happen, add a few ounces of distilled water, which will precipitate a certain quantity of iodide, then filter and add a quantity of nitrate corresponding to the quantity of water added.

When one is compelled to use a bath in such condition for want of time and opportunity to apply the remedy, the crystalline deposit can be prevented by keeping the plate in motion while it is being coated, or by coating the plate collodion side down, either by using a horizontal bath, or by inclining the vertical bath and plate.

Pinholes may also be produced by the presence of acetate of silver in the bath, introduced by the use of carbonate of soda or oxide of silver for neutralizing, and the subsequent, addition of acid. In this case a drop or two of nitric acid will speedily remove the difficulty. They are also supposed to be produced by the use of old and decomposed collodion, or of collodion made with partly decomposed pyroxyline.

The silver bath should be kept covered, to avoid dust and evaporation. The dust brings on decomposition of the solution, and the result is foggy pictures. When small particles of dust, or a black scum, are discovered on the surface of the silver solution, they should be taken off with a strip of blotting paper; or when an overflowing bath is used, the solution should be made to flow over into its smaller portion, from which it is discharged into the bottle. This over-flowed liquid may be used again after filtering.

The silver solution should remain excluded from the light as long as it is in use. It may be kept constantly in the bath, but some prefer pouring it into a bottle every night.

Sometimes the silver solution gets out of order without it being possible to determine the cause. This results, most frequently, from uncleanliness and carelessness; dipping into the bath plates which are not perfectly cleaned, leaving it uncovered, so that the dust floating in the air is deposited in it; exposing it to the light which accelerates the decomposition, and not exposing it long enough to allow it to terminate; accidental contact with developing and fixing solution, etc.

All the causes enumerated above produce the same effect—fogging of the pictures. In all these circumstances the remedy to apply is exposure to the direct sun-light for a few

hours. When no opportunity exists to do this, try an increased addition of nitric acid.

In order to avoid all interruption, resulting from solutions getting out of order, we would recommend to every operator, to have at least two, and to keep the one exposed to the light while the other is being used. With such an arrangement, much trouble is avoided; for a solution which has been used some time always contains organic matter, which, under favorable circumstances, will be decomposed. The proof of this is found in the fact, which every operator can verify, that a solution which has been worked, discolors under the influence of light.

It has been proposed, as a remedy for foggy baths, to precipitate the silver by means of carbonate of soda, and to redissolve the carbonate of silver, thus obtained, in nitric acid, leaving a small quantity undissolved. By this process, the solution is freed from the alkaline nitrates it may contain, leaving in it the nitrates of magnesium, cadmium, or zinc, if any of the iodides or bromides of these metals have been used. This remedy might be used in case the exposure to the direct sun light should fail to restore the bath. We will here give it as described by F. B. Gage, in No. 1, vol. x. of *Humphrey's Journal.*

"Put the foggy solution into a strong bottle, about three times larger than the bulk of the solution; then pulverise and add pure bi-car-

bonate of soda, until the silver is all precipitated to the bottom, in the form of carbonate of silver. If there is any acid in the solution, the soda must be added with caution (stirring, meanwhile, with a glass rod), as the soda will dissolve "fuming," and may boil up and run over, to your loss. After you have added soda until the silver is all precipitated,* fill the bottle with soft water, stir it up thoroughly with the glass rod, then let the precipitate settle. When it has done so, pour off the water, as closely as you can, without letting any of the precipitate escape. Repeat this six or eight times, so as to be sure of washing off all the free soda. Now drain off the water as closely as possible. (It would be well to use distilled water for the last washing, or the kind that you intend to make your bath with.) After having drained it as closely as possible, proceed to add chemically pure nitric acid, to dissolve the precipitate; add it, stirring with the glass rod at the same time, and with some caution, as it will fume strongly; continue to add until the precipitate is nearly, *but not quite all dissolved.* The solution, at this point of the proceeding, will probably be opaque, and almost inky-black. This need not cause any alarm as it will filter out clean and pure. Then take a quantity of clear cotton in

* Add the soda until you are sure the silver is all thrown down. Any excess of soda will be carried off in the subsequent washings, and will do no harm.

your hand, hold it under water and squeeze and work it in your hand until it is thoroughly saturated; then press out the superabundance of water, put it into a funnel and filter the solution through it; test it with the hydrometer, and add water until it is of the right strength; wash your funnel, and put in some clear cotton; filter it again thoroughly, and it is right for a negative bath. For positives, it is only necessary to add one drop of nitric acid, chemically pure, to each three ounces of the solution. Baths for negatives, treated in this way, work decidedly clearer, better, and quicker, than in any way I have ever tried. It also gives better delineations in positives. The experimenter, by this method, will be astonished at the amount of black organic matter that will be found in the funnel, after filtering the first time, and will be able to see what fogged his pictures.

"There are some points of importance to be attend to in this process. They are these:

"1st. That the bi-carbonate of soda be pure.

"2d. That the resulting precipitate be well washed, to free it from all soda that is not absorbed and combined with the silver.

"3d. That the precipitate be *not all dissolved* before it is filtered.

"If this part is not attended to, you will lose all your labor. The theory of this is, that the *organic matter* in the bath is *soluble in*

acid, and cannot be filtered out while the bath is *acid*. There need be but very little precipitate left in, as the least amount undissolved will leave the bath perfectly neutral."

It is the opinion of some, that several samples of collodion, sensitized with different salts, cannot be used in the same bath. This, on investigation, has been found to be an error, the bases of the salts used having no action on the film, with the exception of the iron, as we have seen already.

Collodionizing the melainotype plate and immersing it into the bath, are done with the same facility as the glass plate. It has been objected by some, that the iron plate would decompose the silver solution. This, on trial, is not found to be so, except by a very prolonged immersion. Pure iron has no effect on the nitrate of silver; but iron rust decomposes it. Rusty plates should thus be carefully cleaned before being used.

The niello paper being less dense than the solution of nitrate of silver, cannot be dipped in the same way as the glass or melainotype plate. It is necessary to stick it on a piece of glass of the same size by means of a few drops of water or alcohol

The coating of the plate may be done in the light, but the silvering and developing have to be done in the dark closet. The dark closet should be lighted either by artificial or colored natural light; gas, oil, or burning fluid

will answer; but as small a flame as possible should be used. Natural light is colored by transmitting it through a deep orange pane of glass, or through muslin or paper of the same color.

CHAPTER XII.

Exposure in the Camera.

After having removed the plate out of the bath, allow it to drain a few seconds before putting it into the tablet or plate-holder. The tablet should be carefully wiped after each operation, if not, the nitrate of silver, which has drained in the lower part, and which has come in contact with the wood, will flow over the plate again, and produce silvery stains on the corners. It may, also, happen that it be splashed over the plate, either in putting it into the tablet, or in removing or putting back the slide. The tablet must always be kept in a perpendicular position, to prevent the solution from flowing back, which would cause the same silvery stains.

The plate-holders to be preferred are those with solid glass corners. Those in which the corners are of several pieces, sealed in with glue, are more liable to produce stains than the others, and should be more carefully wiped It will be found useful to varnish, occasionally, the plate-holders. with a solution of gum shel-

lac, in strong alcohol. This will decrease the chances of staining, and will preserve the wood from the corrosive action of the silver solution.

As short a time as possible should be allowed between the withdrawal of the plate from the silver solution and the development. The preliminary arrangements for the sitting should thus be made before the plate is ready. It would not be advisable, however, to have the subject in position and ready to be taken, for he will be tired before the plate is taken out of the solution, and the picture obtained will not have a good expression.

In giving a position every part of the sitter should be arranged in such a way as to be brought in focus on the flat surface of the ground glass. The hands, knees and feet should not be too much forward, or they will appear out of proportion. This should be attended to, mainly, when such object glasses are used which have a curved field, as far as it is compatible with a good and easy position. In case the field of an object glass is too curved, make only small images with it, and use a diaphragm. The camera should be put about at the same height as the head of the sitter.

The way the light should fall on the model depends on the taste of the operator. A northern side light, at 65 or 70 degrees inclination, is generally preferred. The point

where the model should be set depends on the effect of light to be obtained. The image should stand out well on the ground glass, if not, only a flat picture can be the result.

The length of time the coated plate must be exposed in the camera, depends—1st, on the sensitiveness of the collodion film; 2nd, on the strength of the light; 3d, on the focal length of the lenses; 4th, on the quantity of nitric acid in the developer. The melainotype plates, and the niello paper, require the same sitting time as does the glass.

A film prepared in a neutral bath is more sensitive than one prepared in an acid bath. The more acid the bath contains, the less sensitive is the film. Between the sensitiveness of a plate prepared in a neutral bath, and the one prepared in a slightly acid bath, such as we recommend, the difference is trifling.

CHAPTER XIII.

Development of the Picture.

The development consists in bringing out the latent image which has been impressed by the light. Several substances have the property of doing this. The most important ones are the protosulphate of iron, the pyrogallic acid, and the gallic acid. They act in pre-

cipitating metallic silver, in a very reduced state, on the parts of the film which have been impressed by the light. The protosulphate of iron is the only one which is used in the production of collodion positives; pyrogallic acid has, until now, been used by the European artists in developing negatives, but the protosulphate of iron is now coming more into use for this purpose. The gallic acid is used mainly to develop albumen and dry collodion plates and calotype paper.

To develop an ambrotype or a melainotype hold the plate by one corner, and pour the solution on at the bottom of the side clasped in the hand. Use enough of the solution to cover the plate instantly, so that it be covered entirely before the action commences; otherwise the development would go on unevenly. The length of time required to bring the image out will vary, and must be determined by the operator. In supposing the right time be given in the camera, it will depend—1st, On the temperature of the atmosphere; 2nd, On the strength of the developing agent; 3d, On the quantity of acid in the developing agent. The warmer the weather, the stronger the developer and the smaller the quantity of acid, the more rapidly the development proceeds. Nitric acid will retard the development much more than acetic acid. As soon as the image is entirely visible, which will require from eighteen seconds to a minute, throw off the developing solution

and wash the plate immediately with clean water, so as to remove every trace of the iron salt. This is most easily done under a tap.

The appearance of a melainotype or a niello plate, after development, is somewhat different from the one of a glass picture, owing to the black surface which is beneath. The proper development of these pictures will require some more practice by those who are accustomed only to develop the ambrotype.

It is advisable, at times, to vary the proportions of acetic acid and alcohol in the developer. The alcohol has the effect to cause the solution to flow more evenly and unite with the film. The acetic acid produces, to a certain extent, the same effect as the alcohol, and, also, brightens the whites, and preserves the blacks. If the acid is too strong in the developer, the reduction is checked, and the development is slow; if too weak, it is sudden and violent. In the first case it retards the development, and gives a gray tin-foil hue, and the surface is bright and sparkling like frosted silver; in the second case, the image is dull and without luster, of a white color, inclining, when imperfect, to a yellow or gray.

All acids tend, not only to retard the development, but also to increase the length of exposure in the camera. Nitric and sulphuric acid principally do so; acetic acid acts more feebly. When too much nitric acid is present in the developer, or in the bath, it will prevent

the deposition of nitrate of silver in the shades, and thus give a picture without half tones. This is principally seen when thin films or weak baths are used. The remedy is to lessen the acid in the developer, or neutralize it in the bath by means of carbonate of soda, or to iodize more highly the collodion and strengthen the silver solution.

If the protosulphate of iron is in excess, it will be difficult to pour it on the plate sufficiently quick before the action of developing begins. In such a case, after fixing with the cyanide, curved lines will be seen, such as would be produced by a wave of fluid flowing forward, and resting, for an instant, at a particular spot. If the iron is too weak, the development will be slow, and the picture will become slightly metallic on drying.

Free nitrate of silver is required on the plate during the developing process. If, after its exposure to the light, the plate is washed carefully with water, no image will be brought out by the developer. During the exposure of the plate to light in the camera, free nitrate of silver is not required, since a plate washed carefully with water, before its exposure, will give an image if it is dipped in the silver bath before developing. In such a case, however, it is necessary to increase the sitting time; for the free nitrate of silver, on the surface of the film acts as an accelerator. The proportion of nitrate of silver required on the collodion

film—or, what is the same, the strength of the silver solution—should be such as to yield sufficient metallic silver in the development. If the quantity of nitrate of silver was too small, the image would be feeble and imperfect; if too large, it would be too intense and apt to be over developed.

The rapidity of the development depends, in a great measure, on the time the plate has been exposed in the camera. If over exposed, the image will make its appearance in a very short time, and will be too light before the development can be checked by the water. If under exposed, it will appear slowly, the more delicate half tints will not be brought out, and the shades will not be clear. This last effect is most to be feared when there exists any tendency to fogging resulting from the silver solution containing organic matter in decomposition.

An over exposed plate can, with some dexterity, be developed so as to be serviceable. For that, it will have to be watched closely during the action, and the water poured on before the image has become too light. None, however, but imperfect results can be obtained in this way.

CHAPTER XIV.

Fixing the Picture.

The fixing of the picture consists in dissolving in cyanide of potassium or in hyposulphite of soda, the iodide and bromide of silver which remain in the film. The fixing solution can be poured on the plate and flowed back and forth till the picture is cleared off, or it can be used in a flat dish, or in a vertical bath. When cyanide is used, this last method is to be preferred, as the liquid is in this way less exposed to the action of the air, which degages from it vapors of hydrocyanic (prussic) acid. The plate is dipped into it in the same way as it is dipped into the silver solution. Cyanide should never be used in the dark closet. Before proceeding to the fixing, it is very important to have every trace of sulphate of iron washed off, to avoid blue marks, which would otherwise be formed in the film.

The fixing solution should never be too strong. The cyanide mainly, has a dissolving action on the metallic silver which has been deposited. A strong solution can, however, sometimes be used with advantage to darken an image which is slightly too light.

As soon as the iodide of silver has been dissolved from the surface, the plate should again be well washed with clean water. If cyanide of potassium was left on it, the picture would soon change to a brownish hue.

The washing performed, the plate is ready to dry, which can be done spontaneously or by means of a gentle heat from an alcohol lamp.

CHAPTER XV.

Mounting the Picture.

A glass picture can be mounted in various ways. It can be sealed to another glass by means of balsam of fir in the same way as the flint and crown are sealed together to make an achromatic lens. For this, pour a few drops of the balsam on a fine plate glass, lay the picture on it, with the collodion side down, and press gently the two together, so as to spread the balsam all over the surface. One of the glasses should then be coated with asphaltum varnish. None but very level glass plates can be used for this purpose, otherwise the contact would not be perfect. Ambrotypes put up in this way are very permanent, as they are preserved from the influence of air and moisture. For large pictures, which have to be hung up, it will not do, however, the oozing out of the balsam forming air-bubbles between the two glasses. This is especially the case when they are exposed to the heat of the sun.

The ambrotype can also be preserved by coating it with benzine or alcohol varnish, and then backing it with a glass which has been

previously covered with asphaltum varnish, taking care to keep the glasses separated with a paper mat. In this way the color should be applied before varnishing, and will show but very little through the film of collodion.

The most common way is to put up the ambrotype reversed, showing the collodion side which is coated with benzine or alcohol varnish, and backing the glass with asphaltum varnish; then covering with a mat and glass.

Some operators cover the collodion side of the picture first with a white varnish, and then with the black asphaltum varnish; but this throws down the whites, and will in time prove very injurious, by discoloring and cracking.

The pictures on black surfaces can only be put up reversed, like the daguerreotype. They should be coated with white varnish, and then mounted with mat and glass.

To apply the benzine varnish, pour it on the surface of the plate, and let it run off at one corner, as is done in flowing with the collodion. To avoid dust settling on the face, hold the plate downward, after having held it in a vertical position for a sufficient time to set. If the varnish is dirty, filter it through filtering paper, taking care to cover the funnel with a glass plate to prevent evaporation. It is not necessary to use any heat in drying good benzine varnish; it dries rapidly, giving a beautiful surface. In using an alcoholic varnish, it will be necessary to warm the plate slightly.

The picture can be colored, before applying the varnish, or after. In applying them upon the varnish the colors look more brilliant, but will not stand so well.

Pictures for lockets, breast pins, etc. must be taken on melainotype plates or on niello paper, these being easily cut to any size and shape.

Positives on glass can be transferred to oil cloth or on patent leather. For this, they have to be made with tough collodion, which leaves the plate easily. The manner of proceeding is as follows :—The picture being well washed, dried and colored, flow over it the following mixture in quantity sufficient to cover it :

Alcohol,	1 ounce.
Nitric acid,	2 drops.

Then pour the liquid off, lay the plate flat, and lay on it a piece of oil-cloth or patent leather of a size a little larger than the picture. The oil-cloth or patent leather should be previously well cleaned by means of a little flour and a piece of canton flannel. On the oil-cloth or leather lay another glass, and put a spring clothes-pin on each corner, so that the surface on which the picture has to be transferred be pressed between the two glasses. After five or ten minutes remove the clothes-pins, and the back glass and raise carefully the oil-cloth by one corner, when the film will be found to adhere to its surface. Then remove the oil-cloth

a little at a time and with great precaution, and hang up to dry. Transferred pictures need no varnishing, they being preserved by the part of the collodion film which is next to the glass.

CHAPTER XVI.

On Collodion Negatives.

We have seen, in the introductory chapter, that a negative is a kind of type, or *matrix*, by which an indefinite number of positive pictures on paper can be produced, by means of a photographic printing process.

It has been remarked, in both the positive and negative collodion pictures, that the whites, when viewed by transmitted light, are opaque, and the blacks transparent. If such a picture is placed on a piece of paper, prepared in such manner that it blackens when exposed to the action of light, the rays of light will pass through the dark or transparent parts of the glass, and impress the paper; while in the light, or opaque parts, no reduction will take place. Through the middle tints, the light will of course blacken the paper, more or less, according to the degree of transparency. The picture, thus obtained upon the paper, will be a natural representation of the object, as it appears to the eye, and is termed "*a positive on paper.*"

Although all collodion pictures, made on transparent surfaces, present the negative aspect as well as the positive, yet all can not be used to produce "positives on paper." A picture which is seen with advantage by reflected light, that is to say, as a positive, has never intensity enough to give a good print. A "positive on paper," made with it, will be very feeble, or will be dark in the white parts, and devoid of definition and middle tints. Therefore it is required that the deposit of silver should be proportionately thicker than in a positive. To give good positives on paper, the negative should be transparent in the shades, and of such intensity in the high lights, that the light can with difficulty be transmitted, and this must be combined with a natural gradation in the middle tints. Such results are obtained, 1st, by using collodion made with pyroxyline, which gives porosity to the film; 2nd, by using a neutral, or very slightly acid silver solution; 3rd, by giving a longer exposure in the camera; 4th, by omitting nitric and sulphuric acids in the developing solutions; 5th, by redeveloping, strengthening or coloring the negative which has been obtained.

The absolute intensity of a negative does not depend entirely on the thickness of the deposit of metallic silver, but to a great extent on the color it has when viewed by transmitted light. Some negatives are translucent, and of a brown yellow; others of a dark bluish black;

others are grey, etc. It is easily understood, that a brown yellow negative will be a great deal more opaque to the chemical rays, than one that is grey, supposing the deposit, in both cases, has the same thickness; so that often negatives, having comparatively a slight intensity, will give very good positive proofs.

The color of negatives depends on so many causes, that it is impossible to determine them all. The condition of the bath, the nature of the developer, the quantity of acetic acid contained in the developer, the presence or absence of organic matter in the silver bath, the time of exposure to light, are the principal causes. No positive rules can, therefore, be given, to determine whether a negative is intense enough or not. This can only well be seen, when a positive has been produced from it. A few days practice will, however, teach, on this particular part, more satisfactorily, than what can be given in written instruction.

CHAPTER XVII.

Collodion for Negatives.

In the chapter on Positive Collodion, many things have been mentioned, which are also applicable to negative collodion, and which it would be useless to repeat.

We will thus refer the reader to what we

have said on that subject, and invite him to make a careful perusal of it before he commences the study of this chapter.

A negative has to exhibit in bold contrast by transmitted light all the details which are seen by reflected light in a positive. This requires a dense deposit of silver in the film, which result is arrived at mainly by the qualities of the collodion. The intense qualities of the collodion depend on the pyroxyline, and on the sensitizing.

We have seen already in the chapter on Positive Collodion, that pyroxyline, made at a high temperature, gives a more intense collodion than that which has been made at a lower temperature. The peculiar effect of an addition of bromide to intense collodion has also been spoken of in the same chapter.

In preparing collodion for negatives the operator should dissolve in his ether and alcohol as much cotton as is compatible with good flowing qualities. The object to be attained is to obtain a collodion with much body, and which will at the same time give an even and structureless film. As no definite proportion of cotton can be prescribed, this cannot be always arrived at on the first trial. The best way to proceed, is to mix the ether and alcohol together, and to put into it the cotton, a little at a time, till the liquid obtained is a little thicker than positive collodion, then to let it settle and to coat a plate with it, when it can

be seen if more cotton has to be added, or if the solution has to be thinned. The quantity of cotton to be used being once determined, the same proportions can be adhered to as long as the same sample lasts.

A plain collodion being obtained having body with good flowing qualities, it may be sensitized according to one of the formulas given in the chapter on Positive Collodion, omitting altogether the bromide which may be prescribed. After having allowed it to settle, make a sitting.

The picture, you will obtain will generally be very contrasted and very intense in the high lights, while no half tints will be brought out. If so add a small quantity of bromide or of bromo-iodized collodion, which will reduce the contrast, and bring out the middle tints. If the true relation between lights and shades does not exist yet, add another small quantity of bromide, but be always careful not to add too much of it, or the intensity will be reduced to such an extent that the collodion will be valueless for the purpose it was required. An addition of ten grains bromide of cadmium at a time to one pound of collodion will be found suitable.

It may be also that the collodion, after the addition of iodide, gives the amount of intensity required, and no more. In this case, of course, no bromide should be added. In case the iodized collodion gives images wanting in in-

tensity, it is a proof that the cotton is not of the right kind, and there is no remedy but to allow it to become old.

The alkaline iodides and bromides have, as has been mentioned already, a powerful action on the pyroxyline which has been dissolved in the ether and alcohol. This action results in the change of the film from the tough and contractile to the soft and porous state. This soft and porous state of the film is favorable to intensity, for it allows a dense deposit of metallic silver; whereas, when a tough film is used, the deposit is only on the parts nearer the surface. It is owing to this action of the alkaline iodides and bromides that a collodion, which gives no intensity when fresh, acquires this quality by age.

Ammonia, potash and soda affect the collodion in the same way, but with a great deal more energy. A few drops of ammonia added to collodion, which gives images wanting in intensity, will in a short time bring it to the porous state. Such addition should not be made to collodion sensitized with the salts of cadmium, zinc, etc., as the oxides of these metals would be precipitated. In all cases when ammonia has been added, the collodion becomes alkaline, and should be, after the action is fully produced, made slightly acid again by the addition of a few drops of tincture of iodine or hydrobromic acid.

Negative collodion, the same as positive,

should not be iodized beyond the white and semi-opaque state, and, as it has generally more body, this state is attained by the use of a smaller quantity of iodide than is required for positive collodion.

The intensity of collodion can be much increased by the addition of a few drops of an alcoholic solution of glycyrrhizine, or liquorice sugar. It is, however, not advisable for constant use, as it tends to bring decomposition in the bath.

CHAPTER XVIII.

The Silver Solution for Negatives.

The presence of free nitric acid in the silver solution counteracting the reduction of silver on the film makes it necessary to have the solution for negatives as little acid as possible. Great care should thus be taken to procure a sample of good nitrate of silver. Nitrate of silver, which contains free acid, is generally contaminated also with a substance which is the result of the action of nitric acid on organic matter. The presence of this substance is very unfavorable to intensity, and can only be removed by fusing the nitrate of silver before dissolving it, or, when it is in solution, by neutralizing and

exposing to the light. The following is the formula for the negative silver solution:

Neutral nitrate of silver,	1 oz.
Water,	12 oz. fluid.
Iodide of potassium,	2 grains.

Dissolve the nitrate of silver in eleven ounces of the water, and the iodide of potassium in the remaining ounce, and add the two solutions together, after which let settle, and filter the clear part.

The solution obtained in this way is perfectly neutral, and is very likely to give misty pictures. It has to be made *very slightly* acid, just enough to produce clear shades. One drop of nitric acid might be too much. Instead of adding nitric acid of the ordinary strength, it is best to use a solution of ten drops of the chemically pure to one ounce of water, and to add of this solution one or two drops at a time, till the pictures obtained are clear in the shadows. Instead of nitric acid, acetic acid can also be used.

The strength of this bath should be kept up by the addition of a solution of one ounce of nitrate of silver in eight ounces of water.

The use of dark colored collodion develops nitric acid in the bath. When such collodion has been used, and the appearance of the negatives is pale, and without the required intensity, the solution has to be tested, and if found very acid, neutralized by the addition of a few drops of a solution of carbonate of soda,

until the liquid becomes permanently turbid, It should then be filtered and made faintly acid again by adding a little of the solution of nitric acid.

CHAPTER XIX.

The Developing Solution.

Two different substances are used to develop collodion negatives ; the protosulphate of iron and the pyrogallic acid. Each of these developing agents possesses advantages peculiar to itself. The protosulphate of iron requires only about one-half of the exposure which is required when the pyrogallic acid is used, but it is more difficult to produce a sufficient amount of intensity with the former than with the latter. The protosulphate of iron develops very rapidly, the pyrogallic acid develops slowly. The time of exposure to light must be calculated with greater accuracy when the sulphate of iron is used, because the development, being very rapid, cannot be checked when the sitting has been too long, nor can it be pushed further when it has been too short. When developing with pyrogallic acid, on the contrary, the development can be checked with more facility; and when too short a sitting has been given, the bringing out of the picture can be "pushed." But from this the operator

must not, however, conclude that the time of sitting is not of much importance in the latter case; the advantage gained with the pyrogallic acid is, that he has more latitude in the time of exposure.

The sulphate of iron developer is prepared as follows:

Protosulphate of iron,	3 ounces.
Water,	40 ounces.
Acetic acid, No. 8	4 ounces.
Alcohol,	3 ounces.

The quantity of the iron salt can be reduced in warm weather when the development proceeds too rapidly, or the quantity of acetic acid can be increased.

Pyrogallic acid, although termed an *acid*, is a strictly neutral substance, and would act with too much violence, and produce decomposition of the silver salt all over the plate, if a certain quantity of acetic acid was not added to it.

Prepare its solution according to the following formula:

Water,	1 ounce fluid.
Pyrogallic acid,	2 grains.
Alcohol,	1 drachm.
Acetic acid, No. 8	1 "

In warm weather, the quantity of acetic acid may be increased, and in cold weather it may be diminished, or the proportion of pyrogallic acid increased. The alcohol is added to make the solution flow more evenly over the plate. This solution decomposes after a few days, and becomes brown, so that it is advisable to make

only a small quantity at a time. If, however, it is made four or five times more concentrated than is required for use, it will keep longer. In such cases it can be diluted with pure water as required.

The water used for the developer is required to be pure soft spring, rain, or distilled water.

CHAPTER XX.

The Fixing Solution.

Any of the two fixing solutions employed for positives can be used for negatives. We prefer always using cyanide of potassium, it being more economical and easier washed from the plate than the hyposulphite of soda. In its use, observe that it be diluted to such a point, that it will dissolve the unreduced iodide of silver, without attacking the film itself. Negatives, developed with pyrogallic acid, are more easily attacked by the cyanide, than those developed with protosulphate of iron. If, however, the cyanide takes more than half a minute to fix a whole size plate, no fear need be entertained in regard to its use, when the pyrogallic acid is employed in developing.

CHAPTER XXI.

Practical Details of the Negative Process.

It will not be necessary to say anything in regard to the formation of the film of collodio-iodide of silver in the negative process, it being exactly the same as in the positive process.

The exposure to light of a negative is never less than twice the time required to make a positive. The rule is, to give such a length of time that after development the feeblest radiations are marked by transmitted light. With pyrogallic acid it requires about three times longer exposure in the camera than with the iron salt.

As regards the development of the picture, it is about the same as with positives, when protosulphate of iron is used; but somewhat different with pyrogallic acid. In the production of positive pictures it is necessary to stop the development at a certain stage in order to have good, clear shadows; when negatives are required, the development must be carried to its utmost limits, provided the sitting time has been given right. This is the case both with protosulphate of iron and with pyrogallic acid.

The development with the protosulphate of iron is easier and quicker, the image appearing almost immediately. It is important not to throw the developer off too soon, but to let it remain till no further change is produced.

If, after being developed, the image has not sufficient intensity to give good prints, it must be redeveloped or strengthened. The strengthening is done after the image has been washed and fixed. (See Chapter 22.) The redeveloping is done before exposing the plate to the light. Several methods are in use.

1st. *Redevelopment with nitrate of silver and protosulphate of iron.*—Your image being fully developed, pour the solution off and let the plate drain a moment. Then pour over it a mixture of one part of your silver solution and three parts of distilled water, in quantity sufficient to cover it. Move back and forth with dexterity, so as to have the action equal all over the plate, pour the excess off, and spread your developing solution over the plate again. During each of these two operations metallic silver is reduced on the parts where a deposit has not already taken place, and thus makes them more opaque. If sufficient intensity is not obtained after a first redevelopment, repeat the same operations.

2nd. *Redevelopment with pyrogallic acid and nitrate of silver.*—Wash your plate well so that no sulphate of iron remains in the film, after which you pour over it enough of the pyrogallic acid developer as is necessary to cover the plate ; move back and forth so that the solution unites well with the film and pour it off into a small glass ; then add from five to ten drops of your silver solution, pour the

solution on again, and keep the plate moving till a sufficient quantity of silver has been deposited. If more intensity is required, repeat the same operations.

3rd. *Redevelopment with gallic acid and nitrate of silver.*—Operate entirely in the same way as when pyrogallic acid is used. The solution of gallic acid for redeveloping is as follows:

Saturated solution of gallic acid,	1 oz. fluid.
Acetic acid, No. 8	1 drachm.
Alcohol,	1 drachm.

When developing with pyrogallic acid, hold the plate by one corner, and pour on the developing fluid in quantity sufficient to cover the whole surface. After one or two minutes the image will have come out in all its details. If this image is not intense enough, take a fresh quantity of the developing solution, add to it five or ten drops of the silver solution and pour over the plate again. Repeat the same thing till the image has attained the required intensity. The glass that has contained the mixture of pyrogallic acid and nitrate of silver should be carefully washed out after each operation, or the black deposit that forms in it will cause the fresh solution to decompose.

Redevelopment with nitrate of silver, protosulphate of iron and tartaric acid.—A method of redeveloping by adding a few drops of silver to the ordinary developer, and flowing it again over the plate, has been and is yet in use to

some extent. The objection to it is, that the solution gets muddy in a very short space of time, by the silver being precipitated. By adding to the mixture of sulphate of iron and nitrate of silver a few drops of saturated solution of tartaric acid, the liquid will remain clear, and all the silver it contains will be deposited on the developed image.

The redeveloping solution can be prepared according to the following formula:

Water,	1 ounce.
Sulphate of iron,	20 grains.
Tartaric acid,	6 grains.

Add a few drops of silver solution when ready to use it. This method of intensifying requires no previous washing.

The redeveloping of the negative can be done also after the fixing. In the following chapter we describe some methods of intensifying, which can only be applied after fixing.

A plate which has not been exposed long enough to the light develops slowly. If developed with pyrogallic acid, and much silver solution, the high lights are found to be very opaque, and the shadows transparent; but the half tones are not well marked. When protosulphate of iron has been used, the image will have the same appearance, except that the silver will not be reduced as much on the high lights.

When a negative has been over-exposed, the development proceeds rapidly, and no dis-

tinct image can be seen by reflected light; viewed by transmitted light there is a want of proper contrast between the high lights and the shadows, so that the picture appears flat.

After the image has been developed, the plate must be washed, and the fixing done in the same way as for positives.

The negative requires to be preserved by a coating of gum arabic or varnish, to prevent it from being scratched during the printing. When but few prints are to be made from it, and it is to be handled by a careful printer, the gum arabic solution will answer all purposes. This is made by dissolving by heat one ounce of gum arabic in ten ounces of water, and filtering. It is applied on the negative before it is dry, after it is well drained of the excess of water.

Varnishing the negative reduces its intensity. Thin varnish has this effect less than the thick. It is advisable in all cases to use the gum arabic solution first, as the negative is then made less transparent by the varnish.

The varnishes in the market are made either with alcohol or benzine. Alcohol varnishes require heat in drying, with the exception of Anthony's flint varnish, which is made with ammoniated alcohol; benzine varnishes, on the contrary, dry without heat.

The gums used in the preparation of alcohol varnishes are the white or the shellac, mixed with a small quantity of sandarac or

mastic. Those used in the preparation of benzine varnishes are the gum dammar, copal or amber. The two first will not answer, as they give a film which is sticky. Amber alone furnishes a varnish which answers the purpose. It gives a film almost as hard as the glass itself, and which is not liable to crack. Negatives varnished with it, will stand a greater amount of rough use than those preserved by any other preparation. The amber and benzine varnish is known in the trade as the *Adamantine Varnish.*

CHAPTER XXII.

Strengthening of the Negative.

It is often the case, more especially when the protosulphate of iron has been used as a developing agent, that the negative obtained, although all the feeblest radiations are impressed, has not intensity enough to yield good positives, in which case it must be submitted to a process by which the intensity is increased. This object is attained by redeveloping or by strengthening.

Before proceeding it may be well to understand the difference between the terms redeveloping and strengthening. Redeveloping, as is indicated by the name, means to increase the intensity of the negative by repeating the operations of the development. Strengthening

means, to increase the intensity, by other processes. We have already described in the previous chapter the processes of redeveloping. This chapter will treat specially of the processes of strengthening. Several methods are in use.

1st. *Treatment of the image by sulphuret of potassium, or any other alkaline sulphuret.*—This is the most convenient mode of strengthening, when but little has to be added to the intensity. Dissolve one ounce of sulphuret of potassium in half a pint of water, filter it and keep it in a corked bottle. Fix the negative, wash it carefully, and pour this solution over it. The color will change to a bluish black by transmitted light. When the action has gone through the film, wash carefully, gum, and let dry. By this process the metallic silver is changed into sulphuret of silver. The film is not made much denser, but more impermeable to the chemical rays.

2nd. *Treatment of the negative with tincture of iodine.*—The object of this operation is to convert the metallic silver into iodide of silver, which, by reason of its greater mass and its color, is less permeable to the light.

The plate should be dried and washed with alcohol, before pouring the tincture of iodine over it. When the desired effect has been produced, wash well, first with water, then with alcohol, in order to remove the excess of iodine, which would otherwise act on the silvered paper during the printing.

3rd. *Strengthening with bichloride of mercury and sulphuret of ammonium.*—The film, before it is dry, must be converted, partially or entirely, into the double chloride of mercury and silver by the application of a solution of bichloride of mercury, then washed thoroughly, and treated with a solution of hydrosulphate of ammonia. The effect of the bichloride of mercury is, firstly to blacken the image, after which it commences whitening till it has reached a bluish white color. During its action, the operator should inspect the picture from time to time, by holding it up to the light. When the required thickness of the deposit is attained, the action of the mercury salt should be stopped by washing. Care should be taken not to push the action of the bichloride too far, as, after the application of the sulphuret of ammonium, the opacity would be such that it would be impossible to print from the negative.

On pouring the hydrosulphate of ammonia on the negative, it blackens immediately, the double chloride of silver and mercury being transformed into sulphuret of silver and sulphuret of mercury. When it has blackened all through, so that no trace of the former white image can be seen on the side of the glass, the picture should be washed; it has then to be dried and varnished in the ordinary way.

The solution of bichloride of mercury should

not be too strong, in order to prevent the action from being too rapid. One part of the saturated solution with two parts water is sufficient. The saturated solution is made by digesting an excess of bichloride of mercury with water.

The sulphuret of ammonium, or hydrosulphate of ammonia, is sold in solution by druggists. It should be diluted with ten parts of water. As it has a strong and disagreeable smell it should be used out of doors, or near a window where there is a powerful draught. The presence of this gas in the operating rooms is sufficient to cause fogginess of the pictures.

The double chloride of silver and mercury, although in greater mass than the metallic silver which was originally on the plate, transmits the light, so that the blackening or transformation into sulphuret can not be dispensed with.

4th. *Strengthening with iodine, pyrogallic acid and nitrate of silver.*—The image is converted into iodide of silver by leaving it for five or ten minutes in the following solution:

Iodine,	1 grain.
Iodide of potassium,	2 grains.
Water,	1 ounce.

This is done by daylight. The plate is then well washed, taken into the dark room, and redeveloped with pyrogallic acid and silver in the ordinary way. If not intense enough, repeat the operation. By this pro-

cess any amount of intensity can be obtained from weak negatives. It is thus very valuable in making copies of engravings, pencil sketches, etc.

5th. *Strengthening with bichloride of mercury and bromide of potassium.*—The *modus operandi* is the same as in No. 3. Instead of hydrosulphate of ammonia, a two-grain solution of bromide of potassium is used. The color of the image changes to a slate color by reflected, and to orange brown by transmitted light.

6th. *Strengthening with bichloride of mercury and chloride of gold.*—The application of the bichloride of mercury is done in the same way as described in No. 3, and the film is then covered with a one-grain solution of chloride of gold, which changes the color to a bluish black.

7th. *Strengthening with bichloride of mercury or chloride of gold.*—The application of either of these agents darkens the color of the film and makes it more impenetrable to the chemical rays. The bichloride should not be left on longer than is necessary to blacken the film. Both these methods are very useful when the negative has to be strengthened but little to be sufficiently intense.

CHAPTER XXIII.

Alcoholic Collodion.

The proportions of ether and alcohol, which will dissolve pyroxyline, are very variable. Almost any mixture of the two, when they are in the most concentrated state, will do it; but all cannot be used for photographic collodion. The quantity of alcohol which can be used for this purpose is, however, very variable. It is much larger than the ordinary proportion recommended when the cotton is of the variety which gives a tough and contractile film. The advantages claimed for collodion containing an excess of alcohol, are the following:

The film is smooth, structureless and very adherent.

In consequence of its softness and porosity, the film is in a favorable condition for intensity and sensitiveness.

The film sets slowly, allowing plenty of time in the hottest weather before silvering.

The formation of the collodio-iodide of silver in the bath proceeds rapidly.

The collodion keeps longer from the low temperature at which the pyroxyline is made, and the small quantity of ether which enters into its composition.

Pyroxyline,	60 grains or more
Absolute Alcohol,	12 ounces.
Ether, 720 S. G.,	4 ounces.

Put the pyroxyline in four ounces of the al-

cohol, shake well, add the ether, and when all is dissolved, add the balance of the alcohol. Iodize according to the directions given in the chapter on Positive Collodion.

The ether and alcohol used should be of the greatest strength. If none sufficiently strong can be procured, the best that can be found should be concentrated by means of quicklime, as described in the chapter on Collodion.

CHAPER XXIV.

Imperfections in Collodion Photographs.*

We may divide the imperfections in collodion photographs into three sections:

1st. Imperfections common to positives and to negatives.

2d. Imperfections peculiar to positives.

3d. Imperfections peculiar to negatives.

SECTION I.

Imperfections common to Positives and to Negatives.

These are fogging, spots, markings of all kinds, etc.

FOGGING.

The causes which produce fogging are of two kinds:

1st. Irregular action of the light.

2d. Impurity of the chemicals.

* The method of classification of this chapter has been adopted from T. Hardwich's Photographic Chemistry, a work which we consider of the greatest value, and the study of which we recommend to every photographer

A. *Over-exposure of the plate.*—This is often the case with beginners, who do not know the sensitiveness of the collodion process. Over-exposure gives only the appearance of fogginess, when three or four times longer sitting is given than what is required. If the plate is not so much over exposed, the image is pale and flat in the lights, and misty in the shadows.

B. *Too much light in the dark room.*—1st, Owing to the orange pane of glass through which the light is admitted into the dark room being too pale. It is best to work by transmitted light, through either two thicknesses of orange, or one of orange and one of red glass combined. 2d, By the light of the candle or lamp being too strong. When the film is very sensitive, it is prudent to keep the lamp screened by an orange glass. The fogginess resulting from the action of the light may sometimes only be on a part of the plate, as is the case when the light acts on it while it is in the silver bath.

C. *Light entering in the camera, or in the tablet.*

D. *Direct light of the sun falling upon the lens.*—This produces a reflection in the camera and diminishes the vigor of the image.

E. *Diffused light of the sky falling upon the lens.*—This is often the case when taking views. Put on the mouth of the object

glass a tube seven or eight inches long, and blackened inside. In this way there will be admitted only the rays proceeding directly from the object exposed, and the diffusion produced by the lateral rays will be avoided. The same result may be obtained by using a diaphragm with a small aperture, placed two or three inches distant from the lens.

SECOND—IMPURITY OF THE CHEMICALS.

A. *Use of fused nitrate of silver in preparing the bath.*—The fogging is caused by an excess of nitrate of silver. The remedy is the addition of a few drops of the diluted nitric acid. Baths prepared according to the formulas given in this work will not present this inconvenience.

B. *Use of Alkaline Collodion.*—Collodion can be made alkaline by the use of iodide of potassium which contains carbonate of potash, as is sometimes the case. Alkaline collodion is always colorless; it restores the blue color to reddened litmus paper. The remedy is to put in a few drops of hydrobromic acid, so as to give it a pale yellow color.

Collodion prepared with iodide or bromide of cadmium remains colorless too when the ether, alcohol, and gun cotton are free from acid. This is not, however, a mark of alkalinity, but of neutrality. A few drops of hydrobromic acid can only improve such collodion

when it is used with a neutral bath, or very slightly acid developing solution.

C. *Alkalinity of the bath.*—The bath becomes alkaline when an excess of carbonate of soda, or of any other alkali, is added to it for the purpose of neutralizing the acid. In this case, filter and add nitric acid until it does not, by a long immersion, restore the blue color to reddened litmus paper, and the images obtained are clear.

Rain water sometimes contains traces of ammonia, which may make the bath alkaline. Hard water, containing *carbonate of lime*, will produce the same effect.

D. *Decomposition of the bath by organic matter.*—This decomposition is accelerated by exposure to light. If exposed to sunlight, the solution will discolor, and, after a short time, deposit a black powder, which is nothing but reduced silver. It is then again ready for use. Before being exposed to the light, it is best to neutralize the solution by the addition of carbonate of soda. (See pp. 14 and 64.)

E. *Introduction of developing or fixing fluids into the solution,—prolonged contact with rusty iron, etc.*—If the neutralization and exposure to sunlight have no effect, precipitate the silver with carbonate of soda, and re-dissolve in nitric acid, as prescribed on page 85.

F. *Vapors of ammonia, hydrosulphate of ammonia, cyanide of potassium, etc. in the dark room.*

G. *Re-dipping the plate into the silver solution*

before developing it, without allowing it to drain well.

H. *Imperfect cleaning of the glass.*—In this case the reduction is observed between the collodion film and the glass. It results often from the cleaning rags not being dry, or soiled with the developing or fixing solution.

SPOTS.

Spots are opaque or transparent by transmitted light, white or black by reflected light.

Opaque Spots are Produced:

A. *By collodion having small particles in suspension.*—Comet-shaped specks are produced by this cause. Also little circular specks, which, after washing, leave holes.

B. *By not cleaning the mouth of the bottle, so that fragments of dried collodion are floated on to the plate.*

C. *By dust in the tablet or in the camera, or by moving the slide in and out of the tablet with violence, so that small particles of organic matter or drippings of the plate are spattered on the film.*

D. *By the drippings of the plate not coming in contact with the wood of the tablet or with the glue with which the glass corners are sealed in.*—The plate should be well drained, and a piece of blotting paper put on the back, so that all the drippings be absorbed by it. The corners should also be dried after each operation. Tablets with solid glass corners are

preferable to any other kind. Those with pieces of glass glued in the corners give great trouble when they are new. The best course in this case is to take the pieces of glass out and seal them in again with beeswax. This is easily done by putting a small piece of wax in the corner, warming the piece of glass on the point of a knife, and pressing it down on the wax. The spots produced by the tablet are mostly on the lower corners, above the head, in a portrait.

TRANSPARENT SPOTS ARE PRODUCED,

A. *By the silver solution being over-saturated with iodo-nitrate of silver.*—The solution becoming weakened by use, the iodo-nitrate will take a crystalline form and deposit on the film, and will afterwards be washed off, or dissolved by the fixing solution, leaving little transparent spots like pin-holes. The remedy has been given on page 83.

B. *By small particles of iodide of potassium, or of bromide of potassium, or ammonium in the collodion.*—Allow the collodion to settle, and add some collodion iodized with the cadmium salts.

C. *Small particles in suspension in the developing solution.*—The developing solutions should always be carefully filtered before being used.

D. *By a deposit formed on the side of the bath,* a deposit which is the result of the decomposition of the silver solution by organic matter.

The remedy is to clean the bath well out and filter the solution.

E. *By irregular action of the developing fluid.*—The silver solution which is on the plate may be washed off in some places by the developer not being properly poured on. In this case the reduction of silver will not take place on that part of the plate, and a greenish transparent spot will be produced.

Markings of Various Kinds.

A. *A reticulated appearance of the film, affecting the form of a net-work or honey-comb.*—The collodion is glutinous, or contains too much water. In the first case ammonia will improve it, as will also the action of alkaline iodides. In the second case it is worthless, or can only be used to mix with collodion made with very concentrated ether and alcohol.

B. *The film is cracked all over when dry.*—The collodion is rotten from the cotton having been decomposed in the nitro-sulphuric acid, or from the action of alkalies or alkaline iodides or bromides. Such collodion can be mixed with advantage with a sample which is glutinous, their respective peculiarities destroying each other. Mixed with a variable quantity of good negative collodion, it is just the thing for the dry collodion processes. Such collodion may be improved by an addition of good cotton.

C. *Straight lines traversing the film horizon-*

tally.—These are caused by checks having been made during the immersion of the plate into the bath.

D. *Streaks or lines in the direction the plate has been dipped.*—These streaks or lines are in the film or on the surface. In the first case, they are the result of the action of water on the pyroxyline, and denote one of the following states: The silver solution is too weak; the silver solution is at too low a temperature; the collodion is not well set, or it contains too much alcohol. If the lines or streaks are on the surface so that after the plate is dry they can be dusted off with a camel-hair brush, they are the result of the use of a silver solution which has a tendency to fogging.

E. *Oily spots or lines.*—These occur when the plate is taken out of the silver solution before the alcohol has been dissolved into the bath. They are also caused in the development, when the developing solution does not unite readily with the film. The remedy in the last case is an addition of alcohol to the developing solution. When the solution is poured off before the action ceases, oily lines are formed on the end of the plate which is held uppermost.

F. *Curved lines of irregular development.*—These result, 1st, from over exposure of the plate. 2d, From excess of protosulphate of iron or pyrogallic acid. 3d, From unskillfully

covering the plate with the developing fluid. 4th, From using too small a quantity of developing fluid.

G. *Uneven film of collodio-iodide of silver.*—This is produced, 1st, When the collodion contains too much ether, so that it dries too soon. 2d, When the collodion is made with a bad sample of cotton. 3d, When it is too thick.

In the first case, add strong alcohol, until the collodion contains equal parts of alcohol and ether, and dissolve into it more cotton. In the second, add a large quantity of alcohol, so as to have it in excess. In the third case, dilute with equal parts of ether and alcohol, previously mixed together, and iodized if necessary.

H. *Irregular stains of metallic silver on the surface of the film, which can be dusted off and leave a transparent mark.*—These marks are produced by a scum floating on the surface of the solution, and sticking on the plate when it is dipped. Add new solution so as to cause this scum to flow over in the small part of the overflowing bath, or remove it with a piece of blotting paper.

I. *Marks like fern leaves in the film.*—Are caused by an inferior sample of cotton being used, made with weak acids and at a high temperature.

J. *Peeling up of the collodion film after drying.*—This results from a peculiarity of the pyrox-

yline. It happens most frequently on glasses which have not been well cleaned. To prevent it, coat the plate with gum arabic before drying, and if the film commences peeling, varnish the edges with benzine varnish by means of a small soft brush. The remedy is to increase the quantity of alcohol in the collodion, so as to make it softer and less contractile.

SECTION II.

Imperfections Peculiar to Positives.

A. *The image shows well in the high lights, but the shadows are dark and heavy.*—This results mainly from excess of intensity, in which case add bromide to the collodion till the contrast is sufficiently reduced. If such an appearance exists without the high lights being intense by transmitted light, it is the result either of under exposure, or excess of nitric acid in the bath or in the developer.

B. *The shadows are good, but the lights are over done.*—The collodion gives too intense images. Thin with ether and alcohol, or add more bromide.

C. *The image is flat, without sufficient contrast between the lights and shadows.*—This results, 1st, From over exposure. 2d, From the use of collodion which is either too thin or contains too much bromide.

D. *The shadows are grey and misty.*—The bath has a tendency to fogginess, or the image has been over developed.

E. *The whites are grey and metallic, or yellow and dead.*—Good whites are very much the result of a favorable molecular condition of the film. A rather short and porous film gives the best whites. Tough and hard films give generally grey and metallic whites in connection with much acid in the bath or in the developer, and yellow and dead whites when acid has been sparingly used.

F. *The shadows are covered with little specks, similar to those produced on daguerreotypes, by leaving them too long on the mercury.*—The bath contains organic matter. It should thus be exposed to sunlight and filtered. When there is no time for doing this, give an exposure a little longer and develop a little less. This effect is also often produced in re-developing.

SECTION III.

Imperfections Peculiar to Negatives.

A. *Want of intensity.*—1st, From the collodion being made with unsuitable cotton. 2d, From the collodion being too thin. 3d, From excess of bromide in the collodion. As a remedy, add to it as much good cotton as it will bear. If this is not followed by a good result, let it become old. The action of the alkaline iodides or bromides it contains will soon change the condition of the film and cause it to produce intense images. The addition of a quantity of old and red collodion may be resorted to. 4th, Want of intensity

from acidity or impurity of the silver solution. Remedy: Neutralize and expose to the light. 5th, From the plate being kept too long between silvering and developing. 6th, From want of intensity in the light.

B. *Excess of intensity in the high lights and want of definition in the shadows.*—1st, The collodion possesses the intense qualities to a too great extent. Remedy: Addition of bromide or of positive collodion. 2d, The light is too contrasted.

C. *Intensity all over and absence of contrast between lights and shades.*—The plate has been over-exposed.

D. *The high lights are well marked without being very intense, the shadows are deficient in details, and the image looks quite well by reflected light.*—The plate has been under-exposed.

The imperfections mentioned above are common to negatives developed either by pyrogallic acid or by the iron salt, without being *pushed* or re-developed.

CHAPTER XXV.

Positives on Paper.

Two methods are adopted to produce positives on paper. 1st, the ordinary positive process, in which the silver is reduced directly by the light; and 2d, the process called *nega-*

tive, because it is used also to produce negatives on paper, in which the silver is reduced by the subsequent action of light and of a developer.

In the ordinary positive process, the paper is immersed into a solution of some chloride, then treated with a solution of nitrate of silver, so that by double decomposition chloride of silver is produced. It is now dried and exposed under the negative to the light, until a sufficient reduction has taken place, after which the unreduced chloride of silver is dissolved by a solution of hyposulphite of soda.

In the process called *negative*, the paper is floated on a solution of iodide, or bromide, or chloride, and then on a solution of nitrate of silver. Having dried it and placed it under the negative, expose it to the light, and develop the image by means of gallic acid. The unreduced iodide of silver is finally dissolved by hyposulphite of soda.

Selection of the Paper.—The ordinary paper, containing substances which are injurious in the photographic operation, and being of an unequal texture, is unfit for use. Several papers are manufactured purposely. The Saxe of German and the Rive of French manufacture, are best known. The former is much the best as to texture, and printing and strength, but the Rive is preferred by many, principally when albumenized, on account of the rich tone of the prints.

A good photographic paper is smooth, uniform in texture, of an equal thickness in every part, and free from spots. The smoothest side should be used to receive the impression, and the opposite side marked with a pencil. The wrong side of the paper can be easily detected by the wire markings, mainly after it has been salted. These can best be seen by holding the sheet in such a way that the light strikes it at an angle.

CHAPTER XXVI.

Direct Positive Process.

The points to be considered in the preparation of the sensitive paper are: Sensitiveness, intensity, contrast or vigor, delineation, and tone or color.

Sensitiveness.—The sensitiveness of the paper depends:

1st, On the quantity of chloride of silver on the paper. The quantity of chloride of silver is determined by the quantity and species of alkaline chloride used in the *salting*, and by the process of salting. The sensitiveness of highly salted paper is greater than of one in which but a small quantity of salt has been used, provided, however, the quantity of nitrate of silver be in proportion. The sensitiveness however does not increase after a certain point

is reached, and this point depends on the thickness and sizing of the paper, or on the process used in salting. Thick paper and paper sized with gelatine will retain a larger proportion of salt than that which is thin or sized with starch. Immersing salts more than floating, and floating more than brushing. The alkaline chloride used is also a point of great importance, the chloride of ammonium containing more chlorine than the chloride of sodium (common salt), and this more than the chloride of barium.

5 grains chloride of ammonium yield the same quantity
of chloride of silver as.....5½ grains chloride of sodium.
" " .....11 grains chloride of barium.

2d, On the quantity of nitrate of silver on the surface, and on the greater or less facility with which this nitrate of silver is reduced. —When a salted paper is floated on a solution of nitrate of silver, the chloride which is in the paper and the nitrate of silver will decompose each other, forming chloride of silver, which, with the nitrate of silver retained by the paper, forms the sensitive compound on which the image is produced. If the bath is strong, the quantity of free nitrate of silver will also be larger, and the paper will be sensitive in proportion. In case it is brushed on, the quantity of solution which is used will be much reduced in strength, and the paper will be less sensitive than if it is floated. It will thus be necessary in the latter case to use a

stronger solution, if the same result is to be attained. Paper sensitized with an acid silver solution is less sensitive than the one sensitized with a neutral one. The one prepared with the solution of oxide of silver in ammonia (ammonia nitrate of silver) is the most sensitive of all, from the greater facility with which this compound is reduced.

3d, On the use of organic matters. Those generally used are the albumen, gelatine, and iceland moss. All increase the sensitiveness of the paper, but the albumen a great deal more than the others.

Intensity, Contrast, Vigor.

The intensity of the print depends in some measure on the disproportion between the amount of salt and the amount of silver. Salt determines sensitiveness, and silver intensity. Nothing is gained in intensity, however, in using an amount of silver unusually large, and an amount of salt unusually small. The ammonia nitrate gives, in proportion, much more intensity than the plain nitrate of silver. With a weak negative, it should thus be used in preference. Albumen paper gives more intensity than gelatine paper, and this one more than the plain. The presence on the paper of easily reduced salts of silver, such as the acetate, the citrate, etc., also increase the intensity.

Delineation or Sharpness.

Independently of the texture of the paper, the sharpness of the print depends on the use of albumen, gelatine, gum arabic, iceland moss, etc. These substances act in keeping the image on the surface of the paper, and in filling up its pores. Albumen paper gives the sharpest prints of all. Papers prepared with the other substances mentioned, although giving less definition than the albumen, are a great improvement on the plain.

Tone or Color.

The color of a print, both before and after toning, depends in a great measure on the sizing of the paper. The German or Saxe papers print black or bluish black; the Rive or French papers print reddish. The character of these papers remains after they are albumenized.

Weak silver solutions give red tones also, more especially so when used in connection with weak salting. Paper prepared with ammonia-nitrate of silver, or prepared with plain silver, and fumed with ammonia, prints blacker than plain silvered paper.

Whatever be the color of the print on being removed from the printing frame, it can be brought to a more or less pure black in the toning bath. Saxe paper as a general thing, gives a purer black than the Rive paper,

which gives prints of a warmer tone. These remarks hold good whether the paper be albumenized or not; but in the former case, the toning is more difficult and takes longer.

CHAPTER XXVII.

Preparation of the Sensitive Paper.

In the former editions of this work we gave three different direct printing processes: 1st, The process on plain salted paper, floated on a plain solution of nitrate of silver. 2d, The ammonia-nitrate process, or process on plain paper, brushed over with ammonia-nitrate of silver. 3d, The process on albumenized paper. Since then certain modifications have been introduced into the printing processes, which render obsolete a good deal of what we said. We have thus entirely re-written all that appertains to the printing processes, and noticed or mentioned every improvement which has been made in this important branch of photography.

Printing being done generally either on plain or gelatinized paper, or on albumenized paper, we will divide our description of the sensitizing into two parts: 1st, Preparation of the sensitive plain paper; 2d, Preparation of the sensitive albumen paper.

Preparation of the sensitive plain paper.—

Either the Saxe or the Rive paper can be used in this process; the latter giving, under the same conditions, a warmer tint than the former.

The first preparation is the salting, which can be done either with chloride of sodium, of ammonium, or of barium; but the chloride of ammonium, being easier obtained in a pure state, is generally preferred. As regards sensitiveness, color and intensity, these three salts give the same results, when used in equivalent proportions.* The salting solution is made according to the following formula:

Water,	32 ounces.
Chloride of ammonium,	80 grains.
White gelatine,	40 grains.

The gelatine is used in order to introduce into the paper a larger quantity of the kind of organic matter, which easily reduces the silver salts. The effect of its introduction is more boldness and vigor in the print.

The gelatine is put into a part of the water for about an hour, when it will have become soft and swollen. A slight application of heat will then suffice to dissolve it, after which the chloride of ammonium and the rest of the water are added, and the solution is filtered.

A larger quantity of chloride of ammonium may be used, and will increase the sensitive-

* We are aware that a contrary view is entertained by high authority, but we came to this conclusion after some careful experiments undertaken to test this matter.

ness of the silvered paper; but unless the intensity of the negative be increased in proportion to the amount of chloride, the print produced will be grey and cold.

For solar camera dry printing, where a greater sensitiveness is required than for contact printing, as much as ten grains to the ounce may be used with advantage; but no good effect can be expected by the use of fifteen and twenty per cent salt solutions, (corresponding to seventy and ninety grains to the ounce,) such as were used a few years back, principally in Continental Europe.

Some printers add to this salting solution 168 grains of citric acid, and 200 grains bicarbonate of soda. These two substances, acting on each other, form citrate of soda, which, on floating the paper on the silver solution, is transformed into citrate of silver. The effect of this citrate of silver is to give a warmer tone to the print. This addition is not to be recommended when the Rive paper is used.

The paper is immersed in this salting solution, and the air-bubbles removed with a soft brush, after which it is hung up to dry. It is advisable not to leave it in longer than is necessary, in order to avoid the picture sinking into the texture of the paper.

The plain paper can be sensitized in two different ways: 1st, By brushing over it a solution of ammonia-nitrate of silver; 2d, by floating the paper on, or brushing over it, a

solution of plain nitrate of silver, and when dry, exposing it to the fumes of ammonia. Both processes give about the same result.

We will here describe the first process of silvering, and refer the reader for the second process to the heading, *Preparation of the sensitive albumen paper.*

The ammonia-nitrate of silver solution is made in the following way: Dissolve one ounce of nitrate of silver in four ounces of water; of this, reserve for future use about $\frac{1}{2}$ ounce fluid, and to the other $3\frac{1}{2}$ ounces add ammonia, a small quantity at a time, stirring with a glass rod after each addition. A brown precipitate of oxide of silver will form, which, on the addition of a sufficient quantity of ammonia, will be re-dissolved. When this point is attained, the liquid becomes clear again, (unless the nitrate of silver contained certain impurities,) but it will contain an excess of ammonia, which would cause the prepared paper to become brown very quick. To avoid this, add the half ounce nitrate of silver solution which had been set apart, and filter the liquid to separate the precipitate which is thrown down; finally add water until you have a bulk of eight ounces, and put in three or four drops of nitric acid. In this way a solution of nitrate of silver, of the strength of sixty grains to the ounce, is obtained.

The ammonia-nitrate of silver solution should be applied on the paper by means of

a brush or a tuft of cotton, and not by floating it on the solution. The reason for this is, that by the reaction of the chloride of sodium on the ammonia nitrate of silver, ammonia is set free and dissolves in the solution, which in this way takes an excess from the first paper which is floated. This excess of ammonia dissolves the chloride of silver which is formed, and also causes the paper to become brown very shortly after it is sensitized, and sometimes even while it is on the solution.

The most convenient way to apply the ammonia-nitrate of silver solution is by the use of a cotton brush. To make a cotton brush, take a tuft of cotton wool, about four inches long and half as wide, tie a piece of twine in the middle, and by means of this draw the cotton into a glass tube, then cut off what is superfluous.

To silver the paper, pin it on a flat board which you have covered with a sheet of blotting paper, pour on it a small quantity of the silver solution, and brush firstly lengthways, and then across, taking care to distribute it equally all over, after which you hang it up to dry. Be careful to use nitrate solution enough to transform all the chloride of ammonium into the chloride of silver. This will take about four drachms for a sheet of photographic paper. For the first sheet you silver you will have to take one drachm more, that much being absorbed by the brush. The drippings

should not be returned to the stock bottle, as this would bring an excess of ammonia into the solution it contains. The brush can be used several times, if kept out of the dust.

Ammonia-nitrate paper should only be prepared on the same day it has to be used, for it soon becomes brown and loses sensitiveness.

Preparation of the Sensitive Albumen Paper.

Albumenized photographic paper is kept on hand by stock dealers. Both Saxe and Rive papers are used for the purpose. The former is superior in texture to the latter, and is also more free from spots; but the Rive gives prints of a warmer and more pleasing tone. This is on account of the substances which are used for sizing it. The Saxe paper is almost the only one used in this country. Three kinds of Saxe are manufactured: the negative, the half thick, and the thick. The negative and half thick are mostly used for albumenizing.

The albumen for albumenizing paper is prepared in the following manner: Take the whites of fresh eggs well separated from the yolk, and beat with a wooden fork or a bundle of quills, or by means of a patent egg-beater, until the whole has become a perfect froth. This point is reached when the vessel in which the albumen is beaten, can be turned upside down without any liquid running out. Then allow the froth to subside, which will

take several hours; to each ounce of liquid add from five to ten grains of chloride of ammonium. Filter through a sponge or through a tuft of cotton, or let settle, and pour the clear parts into a glass or porcelain tray.

The floating of the paper on the albumen requires some skill, and this is only acquired by practice. The most convenient and easiest way is, to take the sheet by its upper corners, lay it on the surface of the albumen, with its upper end near the lower end of the tray, and then let it come down slowly, gradually pushing the sheet before you. The paper is left on the albumen for one or two minutes, after which it is hung up to dry, suspending either with patent clips, or slinging it over a cord.

The albumen should never be used when it is decomposed and emits a strong smell. Albumen paper should also be kept in a dry place, in order to keep the albumen on the surface from decomposing.

Mr. Thomas Sutton recommends passing the paper through a solution of india rubber in benzine, before albumenizing it. In this way the albumen is kept from sinking in the paper, and the sizing, it is claimed, does not interfere, to the same extent, with the color of the print. The process is patented in Great Britain.

The fuming of the paper with ammonia after it has been sensitized, dispenses with the

use of a strong silver solution. A forty grain solution used in connection with fuming, seems to produce about the same effect as the use of an eighty grain solution used without. The fuming process is now generally adopted.

The question of advantage in the use of strong or weak baths, is one which has lately occupied much of the attention of photographic writers. In our opinion, the strength of the silver solution should depend on the strength of the salting, and on the intensity of the negative ; or, to be more explicit, on the contrast existing between the high lights and the shadows.

Weak salting requires only a weak silver solution, and all beyond a certain strength is superfluous. Strong salting, on the contrary, requires strong silvering. A weak negative requires strong silvering ; an intense one will produce the best results with a weak silver solution.

As a rule, the strength of a silver solution for a given negative or a class of negatives, should be such, that in printing, the shadows are bronzed at the time the lighter parts are sufficiently brought out. If this effect is not produced, either a stronger silver solution should be used, or the paper should be fumed, or both expedients should be used in connection, if one does not give the expected result. If, on the contrary, the dark parts get bronzed long before the lights are sufficiently printed,

producing a print devoid of transparency in the shadows, the solution should be weakened.

The plain silver solution generally used, is prepared according to the following formula:

Nitrate of silver,	1 ounce.
Distilled water,	4½ ounces fluid.
Alcohol,	1½ ounces fluid.
Nitric acid,	2 drops.

The alcohol is added to keep the solution from becoming discolored by use. The way an addition of alcohol produces this effect is explained in the following manner: Albumen forms, with the silver salt, an insoluble compound; but before the compound has time to be completely formed, a small portion of the albumen is dissolved into the bath and discolors it in the same way as any other kind of organic matter would. But, by adding alcohol to the bath, its solvent power is decreased, and with it also its tendency to discolor.

The strength of the solution given above should be kept up by the addition of another one made as follows:

Nitrate of silver,	1 ounce.
Water,	3 ounces fluid.
Alcohol,	1 ounce fluid.
Nitric acid,	2 drops.

It can also be tested from time to time, by means of the *Silver Indicator*,* and the necessary amount of nitrate of silver added to it.

To sensitize a paper by floating, take it by

* Sold by Scovill Manufacturing Company.

two opposite corners, and having bent it into a curved form, lay it on a silver solution, the middle part touching first, and lowering gradually down, taking care to avoid air-bubbles. If these occur, lift the paper up again by one corner, and remove them with a glass rod, or by lifting it up and lowering it down repeatedly.

The paper is left on the solution for about three minutes, after which one corner is lifted up with a strip of glass, and it is removed and hung up to dry, using for this purpose patent clips or clothes pins. In order to make it dry quicker, it is advisable to remove the superfluous silver from the surface, by drawing a glass rod across it.

It is understood that the sensitizing and drying are to be done in a dark room, that is, in a room out of which the chemical light has been excluded. A room with yellow or orange panes of glass in the windows, or with orange paper or muslin stretched before them, will be found a more convenient place to operate in, than a real dark room from which all natural light is excluded, and which is only lighted by a lamp or a candle.

When the paper, after sensitizing, is fumed with ammonia, the formula for the silver solution is as follows:

Nitrate of silver,	1 ounce.
Water,	9 ounces fluid.
Alcohol,	3 ounces fluid.
Nitric acid,	2 drops.

The manipulatory details are the same as described above.

The sensitized paper, being dry, is then fumed with ammonia. This is done in what is called a fuming box. Various models of fuming boxes have been proposed. The one we prefer is made on the same plan as the old daguerreotype coating boxes. It is composed of an oblong box, twenty by twenty-four inches, and about twelve inches deep, with a cover fastened to it by hinges. In the bottom is put a saucer filled with concentrated ammonia. Near the top is a board which can be slid out and in. The sensitized paper is tacked on the inside of the cover, which is shut down and the board pulled out. The ammonia gas which had collected in the space between the bottom and the slide, will fill the upper part of the box, and act upon the paper tacked on the cover. After ten or fifteen minutes, the slide is shut, and the paper taken off when it is ready for printing.

The ammonia used should be of the most concentrated kind, known as *liquid ammonia conc.* It contains in solution as much ammonia gas as it will hold at a low temperature. It should be kept in a cool place, and opened with great care, as accidents often occur from a portion of the liquid being thrown out forcibly, upon the removal of the stopper, when at all warm.

The paper can be over-fumed or under-

fumed. When over-fumed it is more or less discolored, prints of a slaty blue, and tones out of a cold steel color. When under-fumed it prints red and without vigor, and is difficult to bring to a good tone. Paper properly fumed prints vigorous and of a black color, verging slightly on the red, and tones to a warm black tone.

Fumed paper keeps perfectly well for two or three days, and is, in fact, not more apt to turn yellow than the paper prepared on a strong solution of silver, and not fumed. In damp and warm weather, it is advisable, however, to keep either kind in a chloride of calcium box, where it remains perfectly dry, and can be preserved for weeks and even months. This apparatus consists of a zinc or a well varnished wooden box, with a tight fitting cover. In the bottom of this box is a sheet iron pan, filled with dry chloride of calcium. This salt absorbs moisture with great avidity, and is for this reason used as a dessicating agent in chemical operations. Above the iron pan, and resting on a border, is a wire frame, on which is laid the sensitive paper. The box should be kept open as little as possible, to keep out the moisture. After being used some time, the chloride of calcium becomes wet When this happens, take out the sheet iron pan containing it, and warm it on a stove until the salt is again dry. This

operation can be done over and over again, without the salt losing its properties.

Before concluding this chapter we will have to say a few words on a subject which has lately elicited much discussion among photographic writers, to wit: The effect of the addition of nitrate of soda to the silver bath. It is claimed that the addition of a certain quantity of these salts produces an effect similar to that of fuming the paper with ammonia; that is, allows the use of a weaker bath. This assertion is made on apparently good authority, while equally good authority regard the whole matter as absurd.

In our hands the mixed bath of nitrate of silver and of soda has not produced any better results than the silver bath used without this admixture. A series of experiments, undertaken at different periods, with different solutions, and with different kinds of paper, has forced us to come to the conclusion that no advantage arises from the use of the above named salt, either as regards intensity, rapidity or tone, or freedom from mealiness or toning accidents.

The bath containing nitrate of soda always gave a redder print on removal from the printing frame than the plain silver solution: but both prints were brought to the same color in the toning bath.

Mr. Henry Anthony recommends the use of oxide of silver, dissolved in nitrate of am-

monia, for the silvering of paper. The prints obtained by this process equal those on paper fumed with ammonia, the strength of the silver solution being the same.

The way to proceed is as follows: Dissolve one ounce of nitrate of silver in three or four ounces of water, and about one ounce of caustic potash in two or three ounces of water, and mix the two solutions together; a precipitate will be formed, which, in a few minutes, will settle to the bottom. The liquid is then poured off carefully, a fresh quantity of water is added, and after the oxide of silver has again subsided, the water is again poured off. In this way the oxide of silver is washed carefully five or six times, after which crystallized nitrate of ammonia is added, a few drachms at a time, until all but a small quantity of the oxide of silver is dissolved. Finally, the solution is brought to a bulk of twelve ounces, by the addition of three ounces alcohol and a sufficient quantity of water. It is also advisable to add a few drops of nitric acid.

CHAPTER XXVIII.

The Printing.

Printing frames of different forms are used by photographers. They are constructed in such a way that the picture can be examined,

without its position being disturbed. In some, the negative is laid in the frame, collodion side uppermost, the sensitive paper is then placed upon it, then a piece of black cloth is laid upon the paper, the shutter is placed upon the black cloth, and the whole is pressed together by means of two springs. In other frames of a different construction, the paper is laid upon the frame, and the negative is placed on it, and is kept pressed down by means of springs. It is essential that the pressure be equal everywhere, so that the paper be in close contact with every part of the negative.

The paper should be perfectly dry before it is used, if not, it might spoil the negative, mainly when this has been gummed, and it will print of a reddish color in the spots where it is moist.

The preliminary preparations for the printing may be done in diffused light, unless the light be so strong and the chloro-nitrate of silver so sensitive as to cause the paper to darken, which is very seldom the case. Weak negatives should be printed by diffused light; negatives of good intensity may be printed in sunlight, except when the heat is very strong, in which case the varnish might soften and the glass will be in danger of cracking. The printing frame should be laid in such a position as to cause the rays of light to fall perpendiculary on the plate.

The time of exposure is very variable; it depends, 1st, on the sensitiveness of the pa-

per; 2d, on the strength of the light; 3d, on the intensity of the negative. The print should be taken out when it appears slightly darker than it is intended to remain, the toning and fixing reducing its intensity. A little practice will soon teach the operator how far the printing has to be pushed.

On removal from the printing frame, plain paper silvered with ammonia-nitrate, is generally black or purplish black. So is the same paper when silvered and then fumed. The addition of citrate of soda to the salting gives it a slight red tinge. Albumen paper prepared with strong silver, prints slightly red. When prepared with weak silver and fumed, it has a greater tendency to the black. When prints come out of the printing frame too red, the probability is that the silver is too weak; or that the paper has not been sufficiently fumed.

When, on removal from the printing frame, the paper remains white in certain parts, or is covered with white spots, it is a proof that all the alkaline chloride has not been transformed into chloride of silver, which may result from the silver solution being too weak, or from the paper not having been left on it a sufficient time, or also from imperfect silvering with the brush.

CHAPTER XXIX.

TONING, FIXING, WASHING, AND MOUNTING OF THE PRINTS.

The toning and fixing are two very important operations in the production of the photographic print. If the intensity and vigor, and, to a certain extent, the tone of the print, depend on the preparation of the sensitive paper, the permanency depends principally on the toning and fixing.

It is but a short time since the process of toning and fixing together was in general use. Toning properties were communicated to the fixing solution either by repeated use, or by the addition of various substances, such as acids, iodine, chloride of gold, chloride of silver, etc. In all cases, except when chloride of gold was used in connection with a new hyposulphite solution, the red color of the photograph was altered by a combination of the silver compound with sulphur, which, in the hyposulphites, is but loosely combined. This sulphur and silver compound is very unstable, and is acted upon by air, moisture, acid, etc. causing the fading of the photograph. When gold was used in a new hyposulphite bath, the first prints were toned by gold, but after being used some time, the bath would acquire also the property of sulphur toning, so that this process was in the main not more reliable than the others.

The method universally adopted now, is the toning and fixing of the prints separately. This method is at the same time safer, more economical, more expeditious, and gives results superior to those used before.

The operations to be performed to finish the print, after it is removed out of the printing frame, are as follows:

1st, Washing to get rid of the free nitrate of silver.

2d, Toning.

3d, Washing to remove the toning solution.

4th, Fixing.

5th, Washing to remove the hyposulphite.

On removal from the printing frames, the prints are put away in a box or in the dark room; or, better yet, in a chloride of calcium box, and kept there until a sufficient number are collected to begin the toning and fixing. The use of the chloride of calcium box is to be recommended in damp and warm weather, and whenever the prints have to be kept longer than a few hours.

When ready to be toned, the prints are put in a tray with water, to soak out the free nitrate of silver. After five or ten minutes, the water is poured out, and the tray is again filled up with fresh water. This operation should be repeated three or four times, so as to remove all the free nitrate.*

* See Chapter on "Recovery of Silver in Photographic Operations."

The toning bath is prepared according to the following formula:

Water,	40 ounces.
Chloride of sodium,	20 grains.
Bicarbonate of soda,	2 grains.
Chloride of lime,	2 grains.
Solution of chloride of gold sufficient quantity.	

The solution of chloride of gold is made by dissolving fifteen grains of the pure chloride in one pint of water; or a one dollar gold piece* in forty ounces of water.

The chloride of sodium or common salt is added to the toning bath to transform into chloride the nitrate of silver which may remain in the prints, and which would otherwise decompose the chloride of gold.

The bicarbonate of soda has the effect of causing the chloride of gold to yield more readily the metallic gold to the prints. An excess of this salt should be guarded against, or after a short time a double salt of gold and soda would be formed, which does not possess toning properties.

The addition of a small quantity of chloride of lime to the toning bath improves it considerably. Black tones and pure whites seem to be more easily produced. The chlo-

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* A one dollar gold piece can be dissolved in four drachms of a mixture of one part nitric and three parts hydrochloric acid, then diluted with three or four ounces of water; after which a strong solution of carbonate of soda is added a little at a time, until a green precipitate of carbonate of copper is formed. The solution is then filtered and diluted with sufficient water to measure forty ounces.

ride of lime possesses great advantages whenever the paper, for some reason or other, is discolored.

The quantity of chloride of gold solution to be added depends entirely on the number of prints to be toned. Fifteen grains of the pure chloride should tone about ten sheets photographic paper, and the solution made with a dollar gold piece should tone about twenty sheets. Whenever but a small number of prints have to be toned, it is preferable to add the necessary quantity of gold to a smaller quantity of the bath.

The toning bath should have been prepared a short time before being used, for if too fresh it is apt to produce mealiness. One made according to the formula given above, will work best an hour or two after it has been mixed. If it should lose its energy before all the prints are toned, more of the gold solution should be added.

The prints are taken out of the water, and immersed in the toning bath, where they are kept in motion during the whole process of toning. They may at first get slightly redder, but they will afterwards pass through all the intermediate stages, between the color they have on immersing and the blue black. The toning can be stopped at any stage by immersing the print in a tray of clear water, kept on hand for the purpose. The real color of the print is only seen after the immersion

in the hyposulphite fixing solution, so that the operator will have to discern to what tint the print should be brought to assume, after fixing the color he wants. As a general thing the bluish black changes to a pure black in the hyposulphite; less toning than is required to give the bluish black produces prints more or less brown; if the toning is pushed further, the prints are liable to be bluish and ashy colored when dry. This holds good for plain or for albumen paper. Albumen paper silvered and fumed, tones much easier and is less liable to mealiness than the one which has not been fumed; the same can be said of albumen paper prepared on the solution of oxide of silver in nitrate of ammonia. If a large number of prints have to be toned, the toning bath should of course be made larger; but in most cases it would be hardly necessary to use more than a quart or three pints of solution. The gold necessary for the toning should not be used all at once, but one or two ounces of the solution at one time. In this way is avoided a too rapid action, which most always brings with it spots or mealiness on albumen paper.

The time necessary for toning an albumen print should be from two to five minutes. Prints on plain paper, fumed or silvered with ammonia-nitrate, tone much quicker.

The toning bath may be used over and over again, by adding a fresh supply of gold, if

care be taken to avoid the introduction of hyposulphite. The effect of the introduction of hyposulphite in the toning bath, is to make it lose its energy.

The prints, as soon as they are taken out of the toning bath, are immersed in water. They are then washed several times and put into the fixing bath, which is composed as follows:

Hyposulphite of soda,	8 ounces.
Bi-carbonate of soda,	1 drachm.
Water,	32 ounces fluid.

The fixing will not require more than ten minutes. It is done when the paper presents, by transmitted light, an uniform appearance, showing no opaque spots of undissolved chloride of silver.

The fixing solution will, by being used, acquire toning properties which are very objectionable, as they are due to liberation of sulphur. The operator should thus not, for reasons of economy, use this solution too often, and in such way endanger the permanency of his prints. The above given quantity can be used to fix about sixty 4-4 size prints.

On immersion in the hyposulphite, the real color of the print shows itself immediately. Prints toned to black change very little during the fixing; those which are less toned become slightly redder.

Different Formulæ for Toning Baths.

A great variety of toning baths are used

by photographers, and each one is claimed to be superior to the other. The one we have given above is very simple, and, we are inclined to think, will produce as good results as any. We are not prepared to pronounce on the value of the use of the different substances claimed to possess peculiar virtues in the toning, for want of well attested facts on which to base our opinion. We will confine ourselves here to giving a number of formulæ recommended by the most successful operators.

Toning Bath with Citrate of Soda (Hardwich).

Bi-carbonate of soda..... ..240 grains.
Citric acid.....160 grains.
Water..... ... 1 quart.
Chloride of gold, 1½ grains to a sheet of albumen paper.

In making this solution, an effervescence will be produced, resulting from the freeing of carbonic acid. When it has ceased, the combination of the citric acid with the soda has taken place, and the liquid contains citrate of soda with an excess of bi-carbonate of soda.

Maxwell Lyle's Formula.

Water.....32 ounces.
Phosphate of soda.....½ ounce.
Chloride of gold as above.

Formula with Acetate of Soda.

Water.....32 ounces.
Acetate of soda.....½ ounce.
Chloride of gold as above.

Chloride of Lime Bath.

Chloride of lime (hypochlorite of lime)..... 5 grains.
Water.....32 ounces.
Chloride of gold as above.

NITRATE OF URANIUM BATH.

Nitrate of uranium..... 60 grains.
Acetate of soda..... 120 grains.
Water..... 32 ounces.
Chloride of gold as above.

CARBONATE OF LIME BATH.

Precipitated or pulverized chalk..... 120 grains.
Chloride of calcium..... 24 grains.
Water..... 32 ounces.
Chloride of gold as above.

For all these baths the chloride of gold should be neutral. If acid, a few grains of bi-carbonate of soda should be added to the toning bath.

The washing is another point of great importance. To insure the permanency of the prints, it is essential to wash out all the hyposulphite of soda they contain. The methods of washing used by photographers are various, and depend a great deal on local conveniencies and the quantity of water of which they dispose. The most simple method is to have several trays filled with water, and to change the prints, one at a time, from one tray into another, leaving them ten or fifteen minutes in each. Mr. Shadbolt proposes to drain the prints every time they are changed. If this is done the washing will be a great deal more effectual. What is better yet, is to pass them, after each washing, through one of the *patent clothes wringers*. In this way the larger quantity of the water is pressed out between the rollers, and the print comes out nearly

dry. These clothes wringers are invaluable to amateurs, who make only a small number of prints, but the manual labor they require make them not so well adapted to the use of professional photographers, who have large numbers of prints to wash. Another drawback to the use of the clothes wringer is, that the prints require to be made on strong Saxe paper, the Rive and other papers getting injured during the operation.

An excellent way of washing, but which can only be practiced in cities where waterworks exist, is to lay the prints on a coarse muslin screen stretched on a frame, and allow the water to sprinkle over them through the head of a watering pot fixed to the hydrant by means of a vulcanized rubber tube. This screen or frame should be laid inclined, so as to allow the water to run off easily. The greater the pressure of the column of water, the more effectual the washing will be. The position of the print should be frequently changed. By combining this method with that of Mr. Shadbolt, that is, allowing the prints to drain from time to time while on the screen, a very effectual cleansing is obtained.

Some operators lay the prints flat on a piece of thick plate glass under a stream of water, and press them with a sponge, or roll them with a thick glass tube. Either of these two last ways are effectual, but they entail too much labor.

Messrs. T. E. & C. Bull, of London, constructed a print washing apparatus in which the consecutive washing and draining, recommended by Mr. G. Shadbolt, are performed automatically. It is composed of a tub with a false bottom at about half the height. This false bottom is made of zinc or wood, and is perforated with holes. A syphon of wide diameter is put either in the middle or at the side, at such a height that when the tub is filled up with water, the syphon is started, and the water is rapidly discharged, leaving the prints on the false bottom, where they drain until there is again sufficient water in the tub to lift them off. The stream of water is directed so as to strike the side of the tub slanting; in this way a rotary motion is given to the water, which prevents the prints from sticking together, and keeps them rolling and turning around.

The Rive and some other kinds of paper are very apt to get injured during this operation; and when the prints are of large size, even the strong Saxe paper gets broken and torn.

Mr. Hanbury has recently brought out a washing apparatus, which we think is the best one yet made. It consists of a cradle about eight feet long, two feet wide, and two feet deep. In the middle is a partition which divides it in two, thus forming two troughs, two feet wide and two feet deep. The cradle

is balanced in the middle on an axis, and can tip down about six inches either on one side or on the other. The water-cock is disposed over the cradle in such a way, that when the right hand compartment is down, the water runs in the left hand compartment, and *vice versa*. At the end of each compartment, and at two or three inches from the top, is a syphon, which, as the water reaches its upper extremity, is started and the water discharged. On the side of the cradle and running the whole length of it, is an oblong water-tight box, about four inches square, which is kept half filled with water. Let us suppose that the right hand compartment is down, so that the water is being discharged through the syphon, and the water in the water-box is in the right hand side. The water thus runs into the left hand compartment, and as soon as its weight is sufficient to overcome the weight of the water in the water-tight box, the cradle will tip down, the syphon will be started, the water in the box will flow to the left hand side, and the right hand compartment will come under the water-cock. Then the same operation will be repeated on the right hand side, etc. The quantity of water in the box should, of course, be regulated by experiment, to balance exactly the quantity of water in each trough, when filled up to about six inches from the upper part of the syphon. It may be necessary to have the

water box longer than the cradle, so that the water be further from the center of gravity.

Each trough can be filled with a false bottom, like in Bull's washing machine; or the prints can be hung perpendicularly in the water, in which case the false bottom is useless.

The prints have to be washed until the whole of the hyposulphite is removed. The different tests for hyposulphite are not sufficiently delicate to be of use, quantities of hyposulphite, which are inappreciable to these tests, being sufficient to cause the fading of the print. It is thus impossible to say how long a print should be washed. The great points to be attended to, no matter what system of washing be used, are: 1st, That the prints be drained from time to time, to discharge most of the water they hold; and, 2d, That they be kept well separated, so that the hyposulphite be able to diffuse itself into the water. We are inclined to think that when these conditions are observed, ten or fifteen changes of water, either by hand or by the use of any of the washing apparatus described, are sufficient.

The prints being well washed are hung up to dry, either by means of clips or patent clothes pins. When the paper will stand it, they may be passed through a patent clothes-wringer. They can also be dried between sheets of blotting paper.

Mounting of the Prints.

The print is first properly trimmed to the required size. To do this, it is laid on a piece of glass, another piece of glass of the form and shape of the print is laid on it, and a sharp knife is passed along the edges of the glass. Brass or tin mats are also used for trimming, the point of the knife being then passed along the inside of the mat.

The paste used generally is made with starch or flour. Gum arabic, dextrine, and gelatine can also be used. Starch flour, gum arabic, and dextrine paste become acid by keeping. They should thus, as much as possible, be used fresh.

CHAPTER XXX.

On the Fading of Positive Prints.

When the sensitive paper has been acted upon by light, the image is supposed to be free of silver and organic matter. After immersion in a solution of salt, the nitrate is transformed into chloride, which is afterwards dissolved in the hyposulphite. If without being toned the print is immersed in a solution of hyposulphite, the composition of the image will be very little affected. Prints treated this way are permanent.

When the print is fixed in a bath which,

through unskillful management or otherwise, contains sulphuretting principles, the image is composed of silver, organic matter and sulphur. Experience has shown that this compound is less permanent than the other, especially under the influence of moisture.

If the print before being fixed is immersed in a solution of chloride of gold, the chlorine, which is combined with the gold, will pass to the silver, forming proto-chloride of silver in the middle tints, and sub-chloride of silver in the deep shades, while the gold is deposited in the metallic state. On immersion in the hyposulphite of soda, the sub-chloride of silver is decomposed in metallic silver and proto-chloride of silver, and the proto-chloride is dissolved. The image in this case is thus composed of gold, silver and organic matter, the gold predominating when the toning has been pushed far. Prints toned this way have stood the destructive tests better than any other, mainly when containing much gold.

In the gold fixing and toning bath the print goes through several changes which have not been very well explained, and which result in the image being composed of silver, sulphur, gold and organic matter. The better the supply of chloride of gold is kept up, the more gold and the less sulphur the prints contain. Prints toned in the gold fixing and toning bath are less permanent than those toned with gold and fixed with plain hyposulphite.

When to a solution of hyposulphite of soda an addition of acid of any kind is made, hyposulphite is decomposed, and sulphur is set free, by which the prints which are immersed into it will be toned.

The addition of iodine, per-chloride of iron, nitrate and chloride of silver, etc., to the hyposulphite solution, produce in it unstable salts which have sulphurating properties. It is to the addition by constant use of the nitrate and chloride of silver that the plain fixing solution acquires the property of darkening the image.

The presence of sulphur in the photographic print being one of the main causes of its fading, we have to discard all processes in which it is used as a toning agent. These processes, as we have seen already, are, 1st, The hyposulphite bath which has acquired toning properties by being used. 2d, The one to which acid has been added. 3d, Those made with iodine, per-chloride of iron, etc. 4th, The gold fixing and toning bath. The last one is the least objectionable when the supply of gold is well kept up, as in this case the quantity of sulphur in the print is very small.

Besides the presence of sulphur in the print, fading may be produced by the following causes:

Imperfect washing.—It is important that the least trace of hyposulphite of soda should be washed out of the paper. The water giving

no precipitate with nitrate of silver or bi-chloride of mercury, is no proof that the print is sufficiently washed, as none of these salts are tests for a very small quantity of hyposulphite. The presence of hyposulphite in the print causes it to become yellow firstly in the half tints, and afterwards in the shadows.

Prints properly toned by gold are less affected by a minute quantity of hyposulphite than those toned by sulphur, which in a short time are entirely destroyed.

Moisture and impure air.—Moisture is always a condition favorable to decomposition. If the print has not been properly toned, the fading will go on very rapidly under its influence. Prints toned by gold and well washed resist the effect of damp air quite as well as engravings. But when air, besides being damp, contains sulphuretted hydrogen, sulphuric acid, etc., (products of the combustion of coal and coal gas,) no photograph can long resist its deleterious effects.

Acid paste used in mounting.—Starch and flour paste and gum arabic become sour by keeping, and should be avoided, even when freshly made, as the acetous fermentation which produces this acidity may take place after the photograph is mounted, when it is exposed to the influence of moisture. This acidity is very destructive to prints toned by sulphur. Its effect on prints toned by gold seems to be very limited.

Prints developed to the black stage and fixed in plain hyposulphite are less affected by the destructive causes spoken of above, than those which have not been pushed further than the red or purple stage If these however are toned in the gold toning bath, they are in the same condition as direct prints treated the same way.

The toning by sulphur of developed prints deposits also in the paper the substances which cause their destruction.

CHAPTER XXXI.

INSTRUMENTS USED FOR MAKING ENLARGED PRINTS FROM COLLODION NEGATIVES.—THE SOLAR CAMERA.

If a negative be put in a camera at the place occupied by the plate holder, and the camera be then placed in a hole cut in a dark room, in such a position that the light falls on the negative, and can only be admitted into the dark room by passing through the negative and the tube, an enlarged image will be formed at some distance from the tube. Supposing the same camera to have been used to make the negative, the image will be of the size of life, if the negative occupies the same position as when it was made, and the focussing screen is at the same distance from the tube as the sitter was. If the focussing screen

be brought nearer the tube, and the distance between tube and negative increased so that the two *foci* correspond, the image will become smaller. On the contrary, if the distance between tube and screen be increased, and the one between negative and tube be decreased to a corresponding focus, the image will be larger than life.

It will be remarked that in this arrangement the position of the tube is reversed, so that the front lens is nearest the focussing screen, and the back lens nearest the negative. This is the disposition to be adopted in all cases where copies have to be made larger than the original.

In order now to obtain an enlarged print, all that is necessary is to put a sheet of sensitive paper at the place occupied by the focussing screen.

To make the image more luminous the light of the sun can be reflected on the negative by means of a mirror. The mirror should be fixed in front of the negative, and should both swing and turn on a pivot. The centers on which it turns and swings should be on a level with the axis of the lens. When such an arrangement is used, the box should face the south if possible, in order to be able to use sunlight the larger part of the day. The negative should be covered with a ground glass so as not to have the disc of the sun reflected on the sensitive paper.

The solar camera is an instrument expressly made for the printing of enlarged images. It is constructed on the same principles as the apparatus described above, but has in addition to it a bi-convex or plano-convex lens, of a large diameter, on which the light is reflected, and which condenses it and brings it to a focus at a distance of twelve or fifteen inches. The reflector is a plane mirror, a little wider than the condensing lens, and about three times as long as it is wide. It is arranged by means of two movements so as to be put in all positions, and follow the march of the sun so that the rays may be always reflected perpendicularly to the condensing lens. The tube used may be either a portrait combination or a view lens. A diaphragm with a small aperture is put between the lenses in one case, or in front of it in the other, and the box is made of such a length that the light condensed by the bi-convex or plano-convex lens comes to a focus at the spot where is the aperture of the diaphragm.

The negative is put in a slide which is moved forward and backward by means of a rack work. It will be easily understood that the nearer the negative is to the condensing lens, the larger and the less luminous will be the disc of light thrown on it, and the nearer it is to the tube, the smaller and the more luminous it will be.

The solar camera should, as much as pos-

sible face the south. If it was a little to the east or to the west, the reflector would not be found long enough to throw the sunlight on the entire surface of the condensing lens during the whole day in the winter months.

When the large size solar camera is used, it is convenient to have two single lenses, one of about eight inches focus, and the other of about five and a half inches; or, instead of these, a 4-4 and a half size portrait combination. In connection with a small size solar camera, use a lens of five and a half inches focus, and another one of three or three and a half inches, or a half size and a quarter size portrait tube. The long focus lenses or combinations of lenses are used with large negatives, and the short focus ones with smaller negatives.

The solar camera being placed in the hole cut in the dark room, the negative is put in one of the grooves, and the focussing screen put at a certain distance from the tube. It is to be remarked that the larger the image has to be, the further the focussing screen will have to be in the dark room, and the nearer the negative has to be brought toward the tube. The image is brought to a focus by moving the negative without touching the lens. The focusing should be done by diffused light, using the whole aperture of the instrument, with a portrait combination, or a large diaphragm with the single lens. A diaphragm of half an inch or quarter of an inch diameter,

is then adapted at the place where the rays of light come to a focus, and the sun is turned on. We will remark here, that in this combination the diaphragm, when it is put in the proper place, does not cut off any of the light, all the rays emanating from the negative being condensed to a point at the spot where is the aperture. The function of the diaphragm here is to increase the sharpness of the image and flatten the field, and to cut off the rays which are transmitted through the parts of the negative not covered by the disc of condensed light, and those which are reflected from the sides of the box.

In order not to have in the dark room more light than is necessary, the parts of the negative which have not to be printed should be covered with a mat. The observance of these recommendations is not of such great importance when the direct positive process is used as when the prints are made by development.

The stand which supports the focussing screen, or the sensitive paper, should be perfectly vertical, and rigorously parallel with the negative and the tube, the least deviation causing a distortion of the image. The support on which the solar camera rests should also be perfectly level. To insure the parallelism of the camera and the stand, the operator should paint a series of parallel lines on the floor of his dark room.

The stand should be made on the same

principle as a painter's easel. It should have parallel sides, and be about six feet high, and two and a half feet wide. The part on which the focussing screen or the prepared surface rests, slides up and down, and is fastened with a catch. The stand is kept steady by means of a brace.

CHAPTER XXXIV.

Enlarged Prints by the Direct Positive Process.

Negatives used in this process should have little intensity, and be well marked in all the details. They should also be distinct and clear in the shadows, without great contrast and free from spots and marks. To insure these conditions, the collodion should give an even and structureless film, the silver bath should be in a condition to give images without the least fogginess; the exposure in the camera should only be a little more than for a collodion positive, and the image should be fully developed. The negative should not be varnished, as no varnished surface is free enough of unequalities. It may be protected with a coat of gum arabic or of plain collodion prepared as described on page 114.

In order to obtain prints in as short a time as possible, it is necessary to use a larger proportion of salt or chloride of ammonium in the

paper than for prints by contact. Ammonia nitrate paper salted, with ten grains to the ounce of chloride of ammonium, and silvered with a 60 or 70 grain silver solution, can be used with advantage. The solutions can be prepared according to the directions given in Chapter XXVII, the citric acid and carbonate of soda being used or omitted in the salting, according to the taste of the operator. Albumen paper, strongly salted—that is, 10 or 12 grains to the ounce—will also answer.

The focus having been taken beforehand, the sensitive paper is tacked on a board or stretched on a frame, and put in the place occupied by the focussing screen. The reflector is then turned, so as to throw the sunlight on the negative in such a way as to bring the spark or focus of the rays in the middle of the aperture of the diaphragm. Gradually as the sun moves, the reflector will have to be moved, so as to keep the spark always in the same place. This requires to be done about every one or two minutes.

The time of exposure is regulated by the following conditions :

1st, The strength of the light.

2d, The intensity of the negative.

3d, The sensitiveness of the paper.

4th, The proportion between the size of the negative and the one of the print. It is easy to comprehend that the larger the negative is, the more luminous will be the image, and

the larger the image is the less luminous it will be.

5th, The distance the negative is from the condensing lens.—The further the negative is from the condensing lens, the smaller and the more luminous is the disc of light thrown on it. In order to make prints rapidly, it is thus essential to use a lens of such a focus, that the negative be as far from the condensing lens as possible, so as to be coverd with a small but luminous disc of light.

The toning, fixing, etc., of the image having been fully described in chapter XXIX, it is unnecessary to repeat it here.

The dishes for toning, fixing and washing, can be made of dry wood, and are made watertight by pouring a cement, composed of equal parts of wax and rosin, in the cracks and corners, and varnishing with shellac or copal varnish.

CHAPTER XXXIII.

Enlarged Prints by the Developing Process.

The room which is used for the production of developed prints must be perfectly dark, and all the precautions required in producing collodion pictures should be taken.

The solutions should be well filtered, and everything kept in perfect cleanliness.

The silver solution should be prepared with as much care as in the collodion process, and it should be kept as much as possible free from organic matter.

We will describe here two processes, one which is adapted best to the production of plain prints, on ordinary photographic paper; another, which for reasons of economy and celerity, will be found more useful whenever images have to be made of a larger size.

Developing process on photographic paper.— For this process, it is necessary to have one or several dishes, for iodizing, silvering and developing, a little larger than the picture you want to print. The most economical dishes, and the best and cleanest, are composed of a framework in which a plate of glass is sealed with a cement composed of equal parts of rosin and beeswax. The sides of the framework should be about four inches high and one inch thick. In these sides is a groove half an inch deep and a quarter of an inch wide. The framework is fastened together with screws. Join firstly three pieces, then slide the plate of glass into the groove, and screw on the fourth piece. After that pour into the groove your melted cement, and finally varnish the wood several times with shellac dissolved in alcohol, or with copal varnish. These dishes can be used on both sides, and are very easily cleaned. This is done first with a clean sponge, and then the dish is put with one cor-

ner into a bucket, and water sprinkled over with a watering pot.

For fixing, toning and washing, wooden dishes, well cemented and varnished, will answer.

The paper is floated one minute on the following solution :

Iodide of potassium,	½ ounce.
Chloride of ammonium	¼ ounce.
Distilled water	40 ounces.

The solution can also be brushed over the paper by means of a cotton brush. The paper being iodized is hung up to dry.

The proportion of chloride of ammonium can be varied. When negatives are used, which are intense enough to give good ammonia nitrate prints by contact, the quantity of chloride of ammonium may be reduced to one drachm. With very weak negatives, such as are required to make direct prints by means of the solar camera, it can be increased to one half ounce. The proportion given in the formula is adapted for negatives of medium intensity, and will be found generally useful.

The French and German papers take, after being iodized, a reddish color, which is due to the starch used as sizing. The English papers, which are sized with gelatine, remain white.

The paper should not be iodized longer than a few days before it is used.

The following is the formula for the silver solution:

Nitrate of silver,..... 1 ounce.
Distilled water,..... 12 ounces fluid.
Acetic acid, No. 8,..... 2 ounces.

This solution has first to be saturated with iodide of silver, if not, it dissolves the iodide of silver from the surface of the paper, and nothing but a faint image can be obtained. Two grains of iodide of potassium, dissolved in a small quantity of water, will yield iodide of silver enough to saturate the solution. The solution being filtered, pour into it, a few drops at a time, a solution of acetate of ammonia, until the precipitate of acetate of silver which is formed ceases to be dissolved by agitation, after which filter again. The solution of acetate of ammonia is made by neutralizing aqua-ammonia by means of acetic acid, till the smell of the ammonia has disappeared, and the liquid has a faint acid reaction on litmus paper.

As a developer use in cold weather a saturated solution of gallic acid in distilled or rain water, and add to it a few drops of acetic acid, to prevent it from decomposing. During the summer months, dilute it with an equal bulk of water.

The fixing solution is prepared according to the following formula.

Hyposulphite of soda, ... 16 ounces.
Water,..... 40 ounces.
Bi-carbonate of soda,..... ¼ ounce.

The paper having been iodized and dried, set the image in focus, using to focus upon one of your dishes on the glass of which has been pasted a piece of white paper. The focussing, as we have seen already, should not be done with the sunlight reflected upon the negative, but by diffused light. This being done, pour the silver solution in the glass dish and immerge the paper for about five minutes. When the one sized with starch is used, it is very easy to see when all the iodizing is transformed into iodide and chloride of silver, for the reddish color disappears, and the paper, from opaque, becomes transparent.

In order to have pictures free from stains and spots, the greatest cleanliness is required. The dishes have to be well washed and the solutions filtered. The silver solution has also to be in such a quantity as to enable you to pass the paper through it without pauses, otherwise lines will be produced similar to those found on collodion plates, when checked while dipping them.

After the paper has been silvered, pour off the silver solution, and put the dish in its place on the stand. Fasten the upper part of it to the stand, by means of a string or an iron wire, and put a bottle and funnel under it to receive the silver solution which drains from the paper. Then put on the cover of your tube, put the diaphragm in its proper place, and bring the reflector in such a position that

the spark passes through the center of the aperture. The time of exposure cannot be given, it must be judged by the appearance of the paper. The more intense the negative is, the more it will be necessary to see the image before developing. The more chloride of ammonium has been used in the first preparation, the stronger also the image will have to be printed. If a weak negative was used to produce an image, on paper in which little chloride of ammonium is used, it will be necessary only to see the stronger outlines which will, in good light, take only a few seconds. Chloride of silver thus gives strength to the image, but causes the paper to be less sensitive.

It will be necessary, if the spark changes perceptibly its place during the exposure of the sensitive paper to light, to bring it again into the center by moving slightly the reflector.

The next operation is the development. Lay the dish containing the impressioned paper flat on the table, and cover it with the developing solution, using to pour it on a bottle with a wide mouth. This requires to be done with some dexterity, as lines of irregular development might be produced. It will be necessary in the start to use about eight or ten ounces of the developer to cover well a sheet of photographic paper, but with a little practice, the operator will be enabled to do it with half this quantity. When the paper, by long

exposure, has partially dried, a larger quantity of developer has to be used than otherwise, as it is difficult to cover it in this case.

Two stages in the development are noticed: the first stage, in which the picture appears with almost all of its details, but has a red tint; the second stage, in which but very little more appears, but in which the tint of the picture from red is changed to black. An over exposed print develops with great rapidity, and entirely, before the second stage is reached, and, if the development is carried to that point, will lose the purity of its whites. An under exposed print develops slowly, and becomes black before all the half tones have made their appearance.

The black image obtained by full development to the second stage changes little in the hyposulphite. The tint of such an image is not as pleasing as the one of a direct positive print, properly toned. A much better tone can be obtained by exposing the paper a little longer to the light, developing it to the red stage and toning it in the alkaline chloride of gold bath. Such prints are altered slightly during the toning and fixing, so that they will have to be developed a little stronger than they are intended to appear.

In warm weather the development proceeds rapidly, in cold weather it goes on very slowly. It is advisable then to keep the developing so-

lution slightly warm, by letting it remain near a fire.

It is easy to be deceived by the appearance of the print during the development, for by artificial light it seems always darker than by day light.

When the picture has arrived at the required intensity, the development has to be stopped. This cannot be done by washing it, the gallic acid and nitrate of silver remaining long in the paper, and the development continuing while the proof is soaking in the water. The proper way is to precipitate the silver in an insoluble state by pouring on a solution of common salt. The salt transforms the free nitrate of silver into chloride, and the development is stopped instantaneously. There is no necessity of pouring out the developing solution before adding the salt water. The chloride of silver thus formed can be collected and transformed into metallic silver in the ordinary way.

The picture should not be allowed to remain in the solution of salt, as the salt has the power of transforming into white chloride, the finely divided silver which forms the image.

The development being stopped, the print is washed several times in clean water to remove all the gallic acid, after which it is toned, fixed and washed in the same way as the direct positives. The first washing, the toning and the fixing should not be done in strong light,

as the purity of the whites would be affected. The fixing is done when the yellow appearance given to the paper by the *iodide of silver* has disappeared by transmitted light. The hyposulphite has then to be washed out with the same care and by the same means as in the ordinary printing process.

Instead of silvering, exposing and developing in a dish, the paper can be pinned on a board covered with a sheet of blotting paper, and the solution brushed on. This requires to be done with some dexterity, to avoid marks of the brush or cotton. It is also advisable, to make the silver solution a little stronger, using, for instance, nine or ten, instead of twelve ounces of water to the ounce of nitrate of silver. The focus is taken on the paper itself before sensitizing. After sensitizing, the paper is found to have expanded considerably, so that it has to be stretched out again. The focus also may have to be adjusted again; the sensitive paper being a little nearer the lens.

Another Process.

The process we are going to describe now is different in two respects from the foregoing: 1st, The iodide of silver, instead of being formed by floating the paper alternately upon solutions of iodide of potassium and nitrate of silver, is formed by brushing on it the double iodide of potassium and silver, and decompos-

ing the double iodide by soaking in water. 2d, The paper is rendered sensitive by means of aceto-nitrate of silver and gallic acid, instead of aceto-nitrate of silver alone.

Iodizing.—A solution of double iodide of silver and potassium is prepared in the following way: Take 120 grains iodide of potassium and 120 grains nitrate of silver, dissolve each of these salts in ten ounces of distilled water, and mix the solutions together in a quart bottle. The precipitate which is thrown down is iodide of silver, and is allowed to settle, when the liquid is poured off, and the precipitate is washed several times with distilled water, in the manner described on page 55, the washing with alcohol, of which there is question there, being dispensed with. The iodide of silver is then put into a measure, the measure is filled up to six ounces with distilled water, and iodide of potassium is added to it until the whole of the iodide of silver is dissolved. This will take about two and a half ounces. The double iodide of silver and potassium thus obtained has to be filtered through Swedish paper into a clean and dry bottle.

The paper is floated on this solution, or the solution is brushed over the paper by means of a cotton brush, such as is used to silver the ammonia-nitrate paper, after which it is hung up to dry. One sheet of photographic paper

will take up four or five drachms of the solution.

The next operation consists in decomposing the double iodide of potassium and silver by means of water. We must remark here, that when to a solution of this salt water is added, the iodide of silver will immediately precipitate, for a concentrated solution of iodide of potassium only has the power to dissolve the iodide of silver. When the paper prepared as described above is immersed in a tray of water, the iodide of potassium will dissolve and leave the iodide of silver in the texture of the paper. The paper should be allowed to soak in the water for about half an hour, the water is then changed, and it is left in for half an hour or an hour longer, after which it is hung up to dry. Instead of the first soaking, it may be washed for five or ten minutes under a hydrant or tap, in the way prescribed to remove the hyposulphite out of prints. See page 157. When a number of sheets of paper have to be washed, several may be immersed at a time, if abundance of water is used, and if frequently turned over and changed.

The paper prepared this way is said to keep any length of time. It is of a pale yellow color and is insensitive to light.

Sensitizing.—When required to be used, it is laid down flat, and the back is moistened with a sponge to prevent unequal expansion in the subsequent operations. It is then pinned

or tacked on a screen. The preliminary arrangements to the exposure may have been made beforehand, or the paper which has to receive the image can be used to focus upon. The last plan is more expeditious.

The paper is now ready to be made sensitive to the light. For this, prepare the four following solutions, which we will call, Nos. 1, 2, 3 and 4

No. 1—Nitrate of silver,.....480 grains.
Acetic acid, No. 8..... ..... 4 ounces fluid.
Distilled water,. .. .. 8 ounces fluid.

No. 2---Gallic acid ..... 1 drachm.
Alcohol,..... ..... 2 ounces fluid.
Acetic acid, No. 8,..... 1 ounce fluid.
Distilled water,..... 9 ounces fluid.

No. 3---Solution, No. 1,..... 1½ ounces fluid.
Distilled water,.....10 ounces fluid.

No. 4---Solution, No. 2,..... 2 drachms fluid.
Distilled water,.....12 ounces fluid.

Mix four drachms of solution No. 3, and the same quantity of solution No. 4 together, pour the mixture on the paper, and with a cotton brush spread it equally over the surface, brushing it across the paper and up and down. This should be well attended to, otherwise the marks of the brush might show after development.

When the paper is well saturated, the excess, if there is any, is drained off, and the paper is exposed to the light.

The quantities given above are for a whole sheet of photographic paper.

Exposure to light.—The paper prepared by

this method is more sensitive than the one described before. The developing going on already while the light is acting, it will be necessary to see more of the image before the final development than when no gallic acid is used in the sensitizing. With such negatives as give good prints by contact on ordinary ammonia-nitrate paper, the exposure will have to be continued until the image is well seen in all the outlines, and the half dark shadows are marked. With weak negatives, it should not be pushed so far.

Development.—The developing fluid is composed of one part of solution No. 1, mixed with six parts of solution No. 2. This mixture is spread over the paper with the same brush which has been used to sensitize. This should be done with dexterity and rapidly to prevent marks of the brush being produced. If the paper is of a large size, or if it has been over exposed, it is best to dilute the developing fluid with an equal quantity of water. This is also to be recommended in warm weather. If the paper, by being exposed a long time, has become too dry, it is advisable to brush it over with the mixtures, No. 3 and No. 4, before applying No. 1 and No. 2. The image develops generally slower than when the other process is used. When it has fully appeared, spread over it a solution of salt, which, in precipitating the nitrate of silver in the state of chloride, will stop the development.

Toning, fixing and washing.—The image can be toned in the alkaline gold bath, if any toning is required. For prints which have to be painted, the development can be pushed to the second stage, when no toning will be necessary. The fixing is done in the same solution which has been prescribed for the other process.

It is perhaps well to repeat here that before toning or fixing, the gallic acid should be washed out, to prevent decomposition of the toning or discoloration of the fixing solution.

To work successfully this process, every thing should be kept with the greatest cleanliness. The measuring glass, in which solutions Nos. 1, 2, 3 and 4 are mixed, should be washed out after each operation, and care should be taken to remove the black deposit which forms in it. The mixture of gallic acid and nitrate of silver will keep for hours in the dark, but if the slightest trace of this deposit was present, it would discolor in a few minutes. The same cause necessitates the use of a new brush for each picture.

The great sensitiveness of this process will oblige the operator to use the utmost caution to shield his sensitive paper from the influence of light. Every part of the negative, which is not to be printed, should be covered with a mat, and the diaphragm should be as small as possible, so as to admit no unnecessary light

in the dark room. The artificial light should also be as feeble as possible.

CHAPTER XXXIV.

Preserved and Dry Collodion Processes.

If a sensitized collodion plate is kept for some time, the solution of nitrate of silver, concentrating by evaporation, will dissolve the iodide of silver, and afterwards crystallize, thus destroying the film. The collodionized and sensitized plate should thus be exposed and developed immediately after its preparation, so that the landscape photographer is obliged to have on the spot, where he wishes to take a view, all the paraphernalia belonging to the wet process, including a dark closet or tent, in which to sensitize and develop the plate.

The great disadvantage of this process for out-door work, principally when the site for operating is of difficult access, has naturally induced researches as to the practicability of preserving the collodion film. It was proposed at first, by Messrs. Spiller and Crookes, to use, mixed with the silver bath, some salt possessing strong deliquescent properties, so that the film, after sensitizing, was kept moist. This process, however, gave but imperfect results. Mr. G. Shadbolt then proposed to

cover the plate, after sensitizing, with diluted honey. This was done immediately after withdrawing the plate from the bath; or the plate was washed to remove the larger quantity of nitrate of silver, before the honey was applied. Mr. Llewellyn substituted oxymel, in diluted solution, to honey. Oxymel is a mixture of honey and acetic acid. Both processes were, however, abandoned, on account of the difficulty of keeping the plates longer than a day, and the tendency to fogging, caused by the action of the honey on the free nitrate of silver.

Experiments were then made to use the collodion plate in a dry state. It was discovered, that under certain conditions, a plate which had been washed and then dried, was still sensitive; and, that after a comparatively long exposure, such a plate yielded an image by development with gallic or pyrogallic acid, and nitrate of silver. In this process success seems to depend on the molecular state of the collodion, and on the presence in it of certain kinds of organic matter, which produce a sensitive compound with nitrate of silver. Collodion prepared with a certain variety of pyroxyline, and allowed to ripen, seems generally to possess these qualities. Also, collodion which has been partly decomposed, or to which a small quantity of resin has been added.

The theory of the dry collodion process is

a problem which we will not here attempt to solve. We will merely dwell somewhat on the two conditions necessary to success, which we have just mentioned. First, The collodion film, instead of being hard and horny, should be soft and porous. The reason for this is easily understood. For if the film, after washing and drying, presents a glassy or polished surface, impenetrable to liquids, it will be impossible to deposit reduced silver in its texture during the process of development. Second, The collodion should also contain matter capable of forming a sensitive substance by combination with silver; for it is a well known fact, that iodide of silver, perfectly washed, is quite insensitive to light; and that pure pyroxyline, free from the species of organic matter alluded to, is entirely unaffected by the salts of silver. But iodide of silver, in the presence of nitrate of silver, or of an organic silver compound, is a sensitive substance; so that a plate imperfectly washed, or one prepared with the species of collodion spoken of above, is still in a sensitive condition. But imperfectly washed plates keep but a very short time, so that this means of preserving the sensitiveness is unavailable.

The collodion for the dry process should be prepared with pyroxyline made at a high temperature, and with excess of sulphuric acid, as recommended by Hardwich. Such collodion contains the organic principle neces-

sary in the dry processes; and after it has been kept some time, or when mixed with about one-fourth of old decomposed collodion, the quantity of this principle is increased, and the collodion becomes sufficiently porous.

Although, under the conditions we have spoken of, that is, a porous film, and the presence of a sensitive organic silver compound, negatives can be obtained on plates merely washed and dried, success is more certain, when the plate, after washing, is coated with some organic substance, like albumen, gelatine, gum arabic, tannin, etc. The function of these substances seems to be: First, To fill up the pores of the collodion film, so that it be penetrable by liquid when dry; and, second, To facilitate the deposit of silver during the development.

We will describe now some of the dry processes most in use: 1st, The tannin process; 2d, The tannin and honey process; 3d, The collodio-albumen process; 4th, The Fothergill albumen process.

CHAPTER XXXV.

The Tannin Process.

In the tannin process, as described by Major Russell, the plate is first coated with a solution of gelatine, then collodionized, exciled and washed, and finally coated with a

solution of tannin, and dried. In the case, however, when the collodion used is well adapted to the dry process; that is, when it contains the organic principle before alluded to, and gives a film which is porous when dry, the coating with gelatine can be dispensed with. According to Major Russell, the previous coating with this substance makes success independent of the state of the collodion, and causes the film to adhere better to the glass.

We will divide the description of the tannin process into seven parts:

1. Cleaning of the glass.
2. Collodionizing, exciting and washing.
3. Coating with tannin.
4. Exposure in the camera.
5. Developing.
6. Fixing.
7. Drying and varnishing.

Major Russell recommends that the edges of the glass should be ground, and that the grinding should extend a little way on the surface when the previous coating with gelatine is dispensed with. This operation he describes as follows: The neatest way to grind the glass in this manner, is with a piece of stout sheet copper, along the middle of which has been soldered a narrow strip of the same metal, about one-sixteenth of an inch thick; on the other side a piece of wood may be screwed, to give a better hold. Mix some

silver sand, brown sugar and water, and with a little of this mixture in the angle, rub the thick copper against the edge of the glass, at the same time grinding the upper surface with the lower edge of the thin strip. The plate is held down with the left hand on a piece of wood, or other convenient place, with the edge that is being ground slightly projecting; if it project far, the glass may be broken. The edge and a narrow strip on the surface can in this way be ground without wanding off the angle. The use of the sugar is to render the dirt more easy to wash off. If the plates are to be coated with gelatine, it is better to grind only the edges, for the ground glass impedes the flow of the gelatine, and is not in this case required to make the film adhere.

The cleaning of the glass should be done with the greatest care, as any greasiness would repel the gelatine with which they have to be coated.

Coating with Gelatine.

The following is the formula of the gelatine solution:

Cox sparkling patent gelatine	60 gains.
Distilled water,	12 ounces.
Acetic acid, No. 8,	3 drachms.
Alcohol,	2 ounces.

Put the gelatine with the water in a porcelain evaporating dish, leave it until the gelatine has softened, and warm to effect its solu-

tion. Then add the alcohol and the acetic acid, and filter through a tuft of cotton.

The coating with gelatine should be done in a warm room, free from dust, and the solution itself should be warm enough to flow easily. It can be poured on to the glass out of a wide-mouthed bottle in the same manner as collodion, or the plate can be put on a leveling stand and the solution poured on it, using a glass rod bent at one end, to spread it over the surface. In either case the excess is returned to the funnel to be filtered. The use of the india-rubber pneumatic plate-holder is much to be recommended, as it will avoid the handling of the glass with the fingers.

The plate being coated with the gelatine solution, is set to drain on a sheet of blotting paper.

Care should be taken to have no gelatine on the back of the plate, for it would certainly spoil the nitrate of silver bath.

Gelatinized plates will remain good any length of time if kept perfectly dry.

The collodion should be allowed to dry longer than in the wet process, before dipping, so that the film adheres well to the plate. The plate should also be kept longer in the silver solution, so as to ensure the transformation of the iodide and bromide in the collodion, in iodide and bromide of silver.

COLLODIONIZING, EXCITING AND WASHING.

With the previous coating with gelatine,

almost any good negative collodion can be used. If you want to prepare it expressly for the purpose, use it according to the following formula:

Iodide of ammonium,	24 grains.
Iodide of cadmium,	8 grains.
Bromide of cadmium,	20 grains.
Negative pyroxyline,	50 to 65 grains.
Alcohol,	4 ounces.
Ether,	4 ounces.

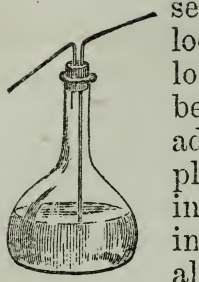
When the plate has not been coated with gelatine, it will be necessary to use a collodion, giving a short and powdery film. The one prepared according to the following directions, will answer the purpose: To four ounces of alcohol add ten grains of bromide of ammonium, dissolved in a small quantity of water, and mix with four ounces of ether. Add then thirty-two grains of iodide of ammonium, and eight grains of bromide of cadmium, and shake until dissolved. If the liquid be opalescent, let it become clear by settling, and to the clear part add from fifty to sixty-five grains of negative pyroxyline, made at a high temperature.

This collodion may give a suitable film immediately after its preparation, but if it does not, it will have the required qualities after being kept a short time.

The silver solution is prepared as follows:

Nitrate of silver,	1 ounce.
Distilled water,	12 ounces.
Iodide of potassium,	2 grains.
Acetic acid, No. 8,	4 drops.

The plates are to be coated with collodion,



sensitized and washed. The collodion should be allowed to dry longer than in the wet process, before dipping, so that the film adheres well to the plate. The plate should also be left longer in the silver solution, so as to insure the transformation of all the iodide and bromide in the collodion, in iodide and bromide of silver. If the common water which is on hand, is pure enough not to give a precipitate with nitrate of silver, it can be used for all the washings; if not, distilled water should be used at first. The washing can be done by means of the washing bottle, (see annexed figure,) or under a tap, or in vertical or horizontal baths.

A very expeditious way is the following: Fill two vertical baths with distilled water, and two or three porcelain dishes, one of which should be large, with common water, and place all near the silver bath. Coat a plate with collodion and sensitize it in the ordinary way, only leaving it a little longer in the silver solution than in the wet process. When it is about ready, collodionize another plate and lay it down on the mouth of a bottle. Now take out the first plate, drain it, and put it in the first washing bath; then sensitize your second plate. If your bath is large enough to hold two plates, you will find

it more convenient to dip the second before taking out the first. Wait now till the second is nearly ready, when you put the first in the second bath, coat a third one, put the second in the first bath and dip the third. Proceed in this way until all your plates are done, removing them from one bath or dish to the other, and leaving them all in the last one, which should be of large size. While the plates are in the washing baths or dishes, they should be moved up and down, to facilitate the washing. The flat dishes or trays should be kept covered to avoid light and dust. The plates are left in the last dish for half an hour or an hour, as it is very important that all the nitrate of silver be removed. They are then ready to be coated with tannin.

Coating With Tannin.

Dissolve four drachms of tannin in twelve ounces of distilled water, filter the solution till it is clear, and add one ounce of alcohol.

The plate having been washed and drained for a minute or two, the tannin solution is poured on it and moved back and forth, till an even coating is obtained, when it is poured off. The same thing is then done with a fresh quantity. The tannin solution used for the first coating may be used over and over again, and the draining of the second added to it; but for the second coating, fresh solution has always to be used.

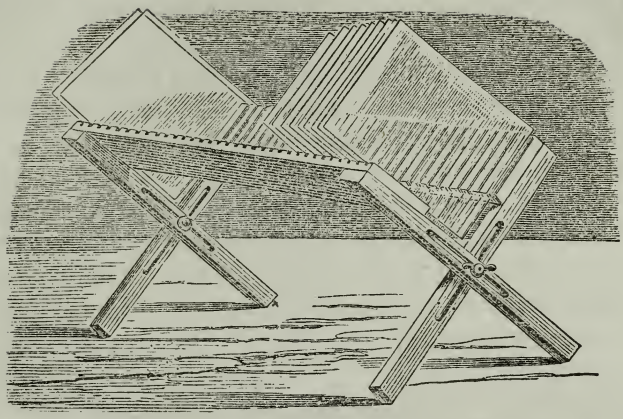


FIGURE 2.

The plate being coated is set to drain and dry on blotting paper, or on a draining stand. (See figure 2.)

Some dry plate workers wash the plate again at this period of the operation, but we have found that the development did not proceed so well when this was done.

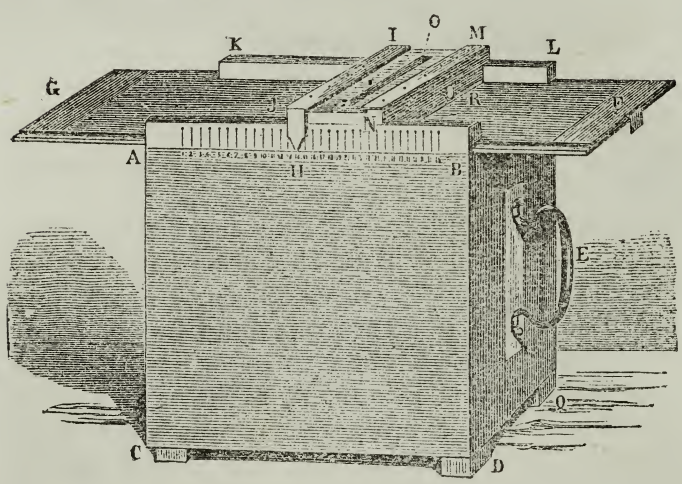
It is almost useless to say that all these operations must be done at night or in a dark room. It is even necessary to use a very feeble artificial light, as the plates would otherwise be acted upon, they being exposed to its influence during a long time.

The drying should not be done by direct application of heat, but rather spontaneously in a room warmed at a moderate temperature.

If the plates have not been coated with gelatine, dip a little brush in any quick dry-

ing varnish, and run it round the edge of the film.

The plates should be kept in a grooved box, with a well fitting cover. If well washed, they will keep their sensitiveness for one month, or perhaps longer. It is safest, however, to put as little time between the preparation and development as possible. The use of a changing box, to change the plate in the open air from the plate-holder, and vice versa, is recommended.



(Figure 3.)

The accompanying cut represents one of these boxes. It is an ordinary grooved box, of which the cover, F G, has an opening O, large enough to slide a plate through. This opening, is kept shut to prevent the admittance

of the light by means of the spring R. The cover slides right and left, and can be set so that the opening O is over any one of the grooves in the box.

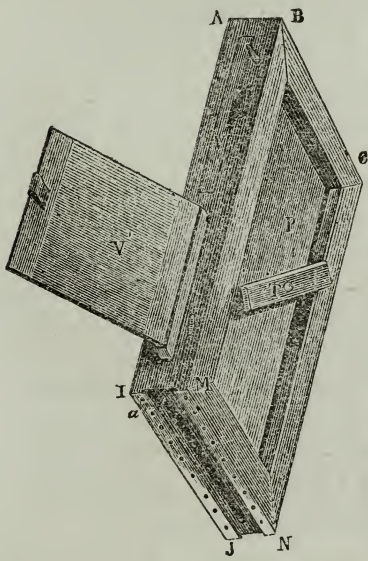


FIGURE 4.

The plate-holder is represented in figure 4. O is an opening to slide the plate through. The back, P, is pushed out by means of springs, and when in that state the slide O is open, but if P be pushed back and T turned, the slide O is shut.—Now to change a plate from the plate-box to the holder slide this on the part I, J, M, N of the cover, loosen the back P, pull the knob R, and turn the box upside down, when the plate will fall in the holder, and the back P is pushed down to secure it. To change the plate from the holder to the box, slide the holder on the cover, loosen the back and pull back the knob.

Some difference will be found in the sensitiveness of the plates. The principal causes of insensitiveness are the use of a collodion

containing no bromide, or of too old a sample, or of a bath containing much more acid than is required to make a bright picture.

Exposure in the Camera.

The time of exposure will range from four to ten times as much as for wet collodion.

Developing.

If the exact time of exposure could be always insured, it would be easy to give a formula for a developing solution, which would always answer. In the dry processes this is impossible, as the time of exposure must always be more or less uncertain, unless each plate is immediately developed, and so the proper time for exposure be ascertained for the next. We can thus only give general rules, which, to produce the best results, must be slightly varied in almost every case. The following formula will be found to give developing fluids suitable for this purpose:

No. 1.—Pyrogallic acid.....26 grains.
Strong Alchohol..... 1 ounce.

No. 2.—Nitrate of Silver.....10 grains.
Citric acid.....20 grains.
Distilled water..... 1 ounce.

For a stereoscopic plate, put one drop of No. 1 in two or three drachms of distilled water and filter into a small glass measure. While this is being done, dip the exposed plate into a bath or dish of distilled water, and after a few seconds immersion, lift it out, allow it to drain and wipe the back dry. Lay

it then on a levelling stand, and having mixed one drop of No. 2 to the diluted No. 1, which has been filtered, pour the mixture on the end of the plate and incline it so as to cause it to flow towards the other end and back in the glass. Repeat this several times, examining the plate by transmitted light, and if nothing appear in three or four minutes add one drop more of pyrogallic. If, on the contrary, the image appears quickly and is full of detail, but looks flat from want of contrast, add more silver. It may happen, also, that from great over exposure the film begins to redden immediately all over, showing the image but faintly; if so pour off the developer and replace with a few drops of No. 2 diluted, when the pyrogallic acid left in the film will be quite sufficient to complete the development. If the image shows about the right contrast and the middle tints begin to appear at the proper time, the No. 1 and No. 2 may be added together, and if too much of either has inadvertently been added, the developer is poured off and replaced by a fresh one in the proper proportions. Should the solution get turbid, reject and make a fresh one.

When no previous coating of gelatine has been used, the collodion will sometimes, on being wetted, expand strongly, so as to be forced up into ridges, but it will generally contract again in ten or fifteen minutes. The

development must not be begun before this contraction takes place.

The development being completed, wash until the oily appearance is removed. The film, when the plate is coated with gelatine, is so strong that it cannot be injured by a heavy stream of water.

Fixing.

Cyanide should not be used for fixing, as any alkaline liquid will losen the film. The strength of the hyposulphite is of little consequence. The proportion we have given for wet collodium, six ounces to a pint, will answer. The film will sometimes become loosened in the first washing. When this happens, wash with a small quantity of water, changing often. The film, if not on gelatine, may crack or split off on drying. It is then the best to cover it after draining with a thin solution of gum arabic.

Drying and Varnishing.

The plates are set to dry on blotting paper, and when dry are coated with any of the ordinary varnishes used for negatives.

CHAPTER XXXVI.

The Tannin and Honey Process.

By using as a preservative a mixture of 15 grains of tannic acid 15 grains of honey to the ounce of water, greater sensitiveness is

said to be obtained than by the use of tannin alone. Mr. England, who proposed this modification of the tannin process, and who practices it successfully, gives the following formula:

PLAIN COLLODION.

Alcohol.....3 parts.
Ether .....5 parts.
Pyroxyline, sufficient to give a tolerably thick film.

IODIZING SOLUTION.

Plain collodion.....2½ ounces fluid.
Bromide of cadmium.....40 grains.
Iodide of ammonium.....30 grains.

IODIZED COLLODION.

Plain collodion.....3 ounces fluid.
Iodizing solution.....1 ounce fluid.

Sensitize in a 40-grain neutral bath and wash in a bath or tray with distilled water, slightly acidulated with acetic acid. Give it a final washing under a tap. Then coat with the solution of tannin and honey, fifteen grains to the ounce of each, and set to dry on blotting paper. If properly prepared and stored away these plates will keep ten months. To prevent the film from leaving the glass pass a sable pencil, previously dipped in a solution of white wax and benzine, round the edge of the plate, to the extent, say, of one-eighth of an inch.

Before developing, the plate is left for about one minute in a bath prepared with 10 grains of nitrate of silver and 5 drops of acetic acid to the ounce of water. By adopting this plan the action of the developer is almost as rapid

as in the wet process. Develop afterwards with the pyrogallic acid solution as usual.

The method of development recommended by Major Russell, and described in the preceding chapter, can also be adopted.

CHAPTER XXXVII.

The Collodio-Albumen Process.

In the Collodio-Albumen Process success is less dependant on the presence of organic matter in the Collodion than in any other dry process used. The reason for this is that the film of iodized albumen, with which the washed plate is covered, is itself transformed into a sensitive substance similar to the one found on the ordinary albumen plates. In fact Faupenot's process is in all respects the same as the albumen process first practiced by Niepe de St. Victor, with the exception that the iodized albumen, instead of being directly used as a coating on glass, is used on a collodionized, sensitized and washed plate.

As far as sensitiveness and success is concerned, the collodio-albumen process, although more complicated, is superior to the plain albumen process. The only drawback is the want of adhesiveness of the film, producing a great tendency to blistering during the development. This can be remedied by using old and decomposed collodion, or collodion made

with a sample of pyroxyline, giving a soft and porous film.

The operations to be performed can be divided as follows:

1. Formation of the sensitive collodion film.
2. Formation of the sensitive albumen film.
3. Exposure.
4. Development and fixing.

Formation of the Sensitive Collodion Film.

The collodion, as we have already noticed, should give a short and powdery film. If prepared expressly for the purpose, the following formula may be adopted:

Sulphuric Ether	8 ounces, fluid.
Alcohol	8 ounces, fluid.
Pyroxyline	100 grains.
Iodide of Ammonium	80 grains.
Bromide of Ammonium	40 grains.

The pyroxyline should be of the variety producing the qualities already spoken of, and the collodion should be allowed to stand for one or two months, so that the alkaline iodide and bromide, by their action on the dissolved cotton, improve the adhesive qualities of the collodion. The plate is coated, sensitized, and washed in the ordinary way, after which it is drained previous to coating with the albumen.

Formation of the Sensitive Albumen Film.

The albumen solution is prepared according to the following formula:

Albumen from fresh Eggs	3 ounces, fluid.
White Sugar	½ ounce.
Distilled Water	1 ounce, fluid.
Conc. Ammonia	10 drops.
Iodide of Ammonium	10 grains.
Bromide of Ammonium	5 grains.

Beat to a froth and allow to subside.

The washed and drained plate is covered with the albumen solution and drained for half a minute. It is then covered with a fresh portion, and set to drain and dry on blotting paper, or on a draining stand. The second portion used on the first plate can be used to coat the second, and that of the second can be used for the third. It should never be returned to the stock bottle. The dried plates should be put in a dark box for future use and can be kept a great length of time.

One or two days before the plates have to be exposed, they are dipped into a silver solution prepared as follows:

Nitrate of Silver	1 ounce.
Distilled Water	10 ounces.
Alcohol	2 ounces.
Acetic Acid No. 8	2 ounces.

An old collodion silver-bath, charged with alcohol, to which the required quantity of acetic acid is added, answers the purpose very well. The addition of alcohol to this silver solution decreases its tendency to discoloration produced by the action of the albumen. If it should discolor, nevertheless, it should be shaken with freshly precipitated and washed chloride of silver, which will absorb the organic

matter producing the discoloration. The plates should be perfectly dry before dipping, in order to avoid blistering. They should be left in the bath about one minute, after which they are washed in two or three dishes of water, and set to dry.

Exposure.

The collodio-albumen plates, like those prepared with tannin, require a long exposure. Much, however, depends upon the collodion, new collodion being a great deal more sensitive than old collodion, but its use has to be avoided on account of the tendency to blistering.

Development and Fixing.

The development is done with pyrogallic acid and nitrate of silver. The process of development given by Major Russell, and described under head of the *tannin process*, is, in all cases, the safest. The fixing and washing need not be dwelt upon, these being the same as in all other dry processes.

CHAPTER XXXVIII.

On Rapid Dry Collodion Plates.

One of the great drawbacks to the dry collodion process is the long exposure required. By various means, however, the sensitiveness of the plates can be greatly increased; but, in

measure, as the sensitiveness becomes greater, the difficulties of the development and the tendency to fogginess increase also. Mr. Thomas Sutton claims that in using a bromo. iodized collodion, containing iodine and bromine in equal atoms (126 of iodine to 78 of bromine,) and using gum arabic instead of tannin, dry plates can be made as sensitive as wet plates. In the hands of many good photographers, who have experimented with this process, great increase of sensitiveness has not been observed.

Dr. Draper recommends that the tannin plates should be dipped in hot water, and developed while yet warm. By this means, the plate can be developed with a much shorter exposure. Doubtless, the same effect is produced on plates prepared by other dry processes.

At the suggestion of Mr. Henry Anthony, Mr. Borda, from Philadelphia, exposed the tannin plate, before using it, to the action of ammonia gas, and in this way obtained a great increase of sensitiveness. Mr. Seahy afterwards found that, after a short exposure, a solution of ammonia developed an image on a tannin plate, which could afterwards be strengthened up with pyrogallic acid and nitrate of silver to any extent. This observation of Mr. Seahy led to what is called *alkaline development.* The exposed tannin plate, after having been wetted with distilled water, is

submitted to the action of a dilute solution of ammonia, carbonate of ammonia, or carbonate of soda. If the exposure has been full, a faint image appears, but it is no condition of success that it should. The alkaline solution is then poured back, and about one-fourth of a three-grain solution of pyrogallic acid, without acetic or citric acid is added, and it is again poured over the plate. This causes the image to appear, in all its details, but very faintly. The plate is then well washed, and the image is intensified to its proper degree of intensity, with the ordinary pyrogallic acid solution, additioned with a few drops of nitrate of silver. By this method of development, the exposure is reduced to twice or three times that given in the wet collodion process; but we repeat here, again, there is a great tendency to fogging or deposition of the reduced silver on the shadows, and it requires great nicety of manipulation, and, before all, great patience in the intensifying, to carry out the process to a successful result.

CHAPTER XXXIX.

On Copying.

As a general thing, copying should be done by the light of the sun reflected by means of a

mirror. The room in which the copying is done, should, if possible, be exposed to the South. No light should be admitted back of the object to be copied. It matters little if there be any windows back of the copying camera; but, in order to avoid reflections, those on the north side and those back of the object should be darkened. This is, however, also the case in the glass room used for portraits. In the morning the copying apparatus is turned toward the East, and in the afternoon toward the West.

When the copy is to be smaller than the original, the ordinary portrait camera can be used, but whenever the object is to be copied larger, the portrait camera will not be found to expand sufficiently. To meet the requirements in this case, a camera specially made for the purpose is necessary. It should expand as much as four or five feet, and be constructed either with bellows or drawers. It is placed on a flat board, at the height of an ordinary table. At one end of the board is placed vertically another board, one and a half or two feet high, on which the picture to be copied is tacked or stuck fast with gum paper. By a little ingenuity, a system can be devised by means of which the picture is raised or lowered, or moved toward the right or left.

The picture should be at right angles with the camera, so that its shape may not be

altered in the copy. It should also be placed in such a position that its center is on a level with the center of the lens.

The lens most generally useful in copying is the single achromatic lens, known commonly as view lens. The photographer will find it advantageous to have two or three of these, of different focus; for instance, one of six inches, another one of ten inches, and a third one of sixteen inches. A quarter size and a half size portrait lens, with central stops, will also answer the purpose. The lens to be used depends not on the size the picture has to be made, but on the size of the original. For instance, a six-inch focus lens may answer very well to enlarge a ninth size daguerreotype, etc., to almost any size; but if the original was a whole size, only the center would be sharp and well defined. In such case, a longer focus lens, giving a larger field, is required. The aim is to use only the rays passing through the central part of the lens, or, in other words, to use only the center of the field.

When line-drawings, engravings, or objects with straight lines have to be copied, the recommendation of using only a small part of the field should be more closely adhered to than when the original is a portrait or landscape. The reasons for this is, that when the whole field, or the larger part of it, is made use of, the single lens produces a dis-

tortion of the marginal lines. To illustrate this, suppose the photographer traces, on a sheet of paper, a diagram in the shape of Fig. 5, about five inches square, and produces an image of it on the ground glass of his camera the same size as the original, by means of a lens which gives only a circle of light, or field, of seven or eight inches. The image, instead of being similar to the original, will assume the shape represented by Fig. 6.

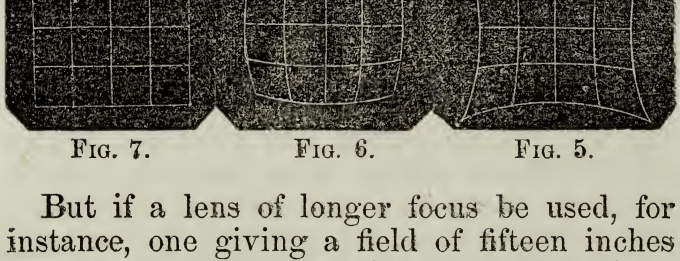


Fig. 7. Fig. 6. Fig. 5.

But if a lens of longer focus be used, for instance, one giving a field of fifteen inches diameter, the distortion will be scarcely visible.

The portrait, or ordinary double combination lens, although quite free from distortion, is not well adapted for copying the style of pictures referred to, on account of the curvature of its field. The orthoscopic lens, manufactured by Voightlander & Son, for which freedom from distortion was at one time claimed, produces a distortion of another kind, illustrated by Fig. 7. The globe lens and the triplet (either Ross' or Dallmeyer's,) give

images practically free from distortion, and should, in consequence, be used, whenever that quality is required, in preference to the long focus meniscus, which requires a copying camera, expanding much more than will be found practicable.

Whenever the illumination of the image on the focusing glass will admit of it, it may be recommended, to improve its definition, and other optical qualities by a use of stops. This should, of course, not be carried too far; for a point exists in which the improvement in the image, obtained by this means, is not a compensation for the disadvantages resulting from the long exposure of the plate.

The objects or originals which the professional photographer generally finds to copy, are daguerreotypes, collodion positives, either on glass or on iron plates, photographs on paper, ink and crayon drawings, engravings, and oil paintings.

In copying daguerreotypes, a recommendation, which should not be overlooked, is to cover the shining brass-work in which the lens is mounted with a scrap of black velvet, so as to avoid its reflection on the highly-polished plate.

Daguerreotypes and collodion positives require about the same time of exposure. This, however, varies greatly, according to the color of the picture. Varnished collodion positives require a longer exposure than those which

have not been varnished. Whenever there is no harmony between the different parts of a picture—for instance, when in a portrait the head is light and the drapery very dark—one part may be shaded off by means of a blackened piece of card-board, and the exposure continued on the other part until the desired effect is obtained.

Photographs on paper require but a short exposure. Whenever circumstances will admit of it, they should be copied by diffused light, in order to avoid the disagreeable roughness resulting from the unequality of the paper when copied by sunlight. By making the photograph wet, and sticking it on a plate glass, this roughness can, however, be avoided.

Engravings, drawings, etc., also require but a short time of exposure. It should be such that when fully developed and fixed, the image looks well as a positive. If the exposure be pushed further, the cleanliness of the lines is lost after redevelopment. The method of redevelopment to be recommended, is that with nitrate of silver and pyrogallic acid, or sulphate of iron and tartaric acid, the film being first partly transformed into iodide of silver by the application of a solution of iodine and iodide of potassium. The collodion used should be simply iodized, or only contain a small quantity of bromide. When the drawing is made on a rough kind of paper, the sunlight should be reflected on it with as little obliquity as

possible, in order to avoid the production of shadows by the inequalities of its surface.

Lead-pencil drawings are among the most difficult subjects to copy, on account of the reflection produced by the pencil-marks and of their grey color. They require a very short exposure, so that the image looks well as a positive. As it is often difficult to bring the negative up sufficiently by redevelopment, without stains and irregularities in the surface, it is advisable to redevelop it only up to a certain point, and then to intensify it with bichloride of mercury and bromide of potassium, or, instead, sulphide of ammonium.

Oil paintings are best copied by diffused light. The glass house, or sky and side light room, used by the portrait photographer, is well suited to this kind of work. The great difficulty consists in avoiding reflections. To attain this, the painting is hung up one or two feet back of the place ordinarily occupied by the sitter, and the light is made to fall on it as much as possible from the front. All unnecessary light, and all that which comes from the sky or the side, should be excluded. The collodion used should be newly made, and contain a maximum of bromide, if the non-active colors predominate in the painting, or if it has become brown by age. Modern oil paintings, however, which are a more faithful representation of nature, are easily reproduced with the ordinary portrait collodion.

CHAPTER XL.

Out-Door Photography.

The outfit for out-door photography should be selected with reference to small weight, compactness and portability. It should consist of the following articles:

A dark tent or developing box; a water-bag; a light folding camera with plate-holder lens, etc.; a light and solid tripod stand; a water level; a bath dish of gutta percha or vulcanite; a grooved box, with glass; a soft camel hair-brush; a bottle of collodion; a strong bottle, well wrapped up, holding the silver solution; a bottle with developing solution; a bottle with the pyrogallic acid or tartaric acid and iron redeveloping solution; a small bottle of twenty-grain silver solution for redeveloping; a bottle with fixing solution; a bottle with glycerine.

These articles should be packed in two light boxes, with strap, so as to be easily carried—one of these boxes to hold the camera, plate-holder, water-bag, etc.; the other to contain the chemicals. When a developing box is used, the chemicals may be packed into it. The tripod stand can be strapped on one of the boxes.

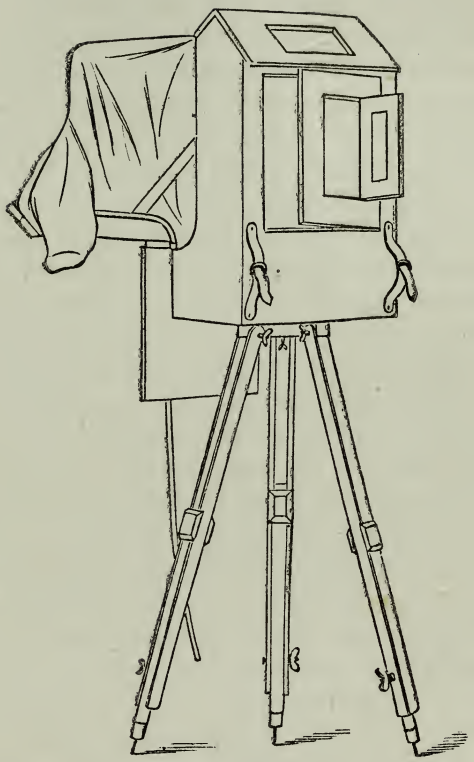


FIG. 8.

The developing box is best suited for small plates, such as those of the stereoscopic and $\frac{1}{4}$ size. Figure 8, represents one of these boxes. Its dimensions are, height, 20 inches; width, 18 inches; depth, 7 inches. The door, which is represented open, is used to take the plate-holder and plate in and out. In it is a

window, with a yellow glass, which can, if necessary, be shut. On the slanting roof is another yellow glass. The tent part of the box is made of India-rubber cloth, and has two sleeves to introduce the hands. It is held up by means of brass rods, which, when the box is to be shut, bend inside of it. On its upper part are two openings to apply the eyes, so as to see the inside while operating. These can be arranged in the same way as in a stereoscope. The horizontal part, to which the India-rubber cloth is attached, is fitted with a sink, made of gray India-rubber cloth, and to this sink is fastened an India-rubber waste-pipe, which is represented in the cut hanging down. The whole box is supported on a light tripod stand, which, when not in use, is strapped on the side of it.

The way to use the box is as follows: The plate and plate-holder are introduced in the box, through the door, and the operator puts his hands through the sleeves and prepares the plate, examining the operation through the holes in the cloth. The plate being ready, it is put into the plate-holder, taken out of the box through the door, and exposed. The development and fixing are done in the same way.

This developing box can be modified, so that the head and upper part of the body be put under the cloth. The tent part will then have to extend about one and a half feet

farther, and be made to hang down, so as to encircle the operator below the waist. This system gives more freedom of motion to the operator, but is very uncomfortable on a hot day.

When large plates have to be used, it is best to have a tent, or a van, covered with oil-cloth. Many models for tents have been proposed, all, more or less, objectionable, either on account of weight or solidity. The handiest one we have used was a piece of double-thick muslin, thrown over a tripod stand about eight feet high, and extended by having five or six ropes attached by one end to the upper part of the cloth, and by the other to some tree or other object near by, or to a spike driven in the ground. The objection to tents is, the annoyance caused by the dust. They should thus be pitched in a grassy place, and, if necessary, the ground around should be sprinkled with water.

A good water-bag can be made of India-rubber, by taking a piece of tubing about six inches in diameter, and cementing both ends by means of India-rubber dissolved in benzine, inserting at one end a mouth of hard rubber, through which the water is poured in, and on the other a tube about eight or ten feet long, which passes into the tent, or developing box, through a little hole. The bag is hung on a tree, or other object, and the end of the tube is closed by means of one of the wooden clips used for hanging up prepared paper.

The camera should be as light as possible, and fold up so as to present but a small volume. The lens should be fixed on a board which slides up or down, so as to allow of more sky or more foreground, according to circumstances. The tripod stand should combine the advantages of small weight with that of solidity. A light and very solid stand can be made of the kind of cane used for fishing-rods.

The bath dish ought to be made of a material which is not liable to break. Vulcanite, or gutta percha, answer best. If the cover be made to fit tightly, it will save the carrying of a bottle to hold the silver solution.

Some landscape photographers cover the plate, after it has been developed and drained, with a diluted solution of glycerine, and perform the fixing and redeveloping as strengthening at home. When this plan is adopted, the outfit is considerably reduced, no water, fixing solution nor redeveloping solution being required.

The lenses used for making views, are the meniscus, or single achromatic lens, the globe lens, the triplet, the orthoscopic, and, sometimes, the double combination or portrait lens. The single achromatic lens is the best for general purposes. When sufficiently diaphragmed, it gives a definition superior to that given by any other lens. For architectural subjects, it will not answer so well, unless used at a sufficient distance, on account of the distor-

tion of the marginal lines. The globe lens is free from this defect, and is thus well suited to architectural subjects, especially when there is little space in front.

The globe lens possesses, also, much depth of focus; that is, it brings objects situated at different planes in focus at the same time. It is not equal in definition, however, to the single lens, and always requires to be strongly diaphragmed to correct the spherical aberration. It has the advantage of giving an image including an angle of view two or three times as wide as that given by the meniscus.

The triplet, manufactured by Dallmeyer, (London) also gives images free from distortion, and includes the same angle of view as the globe lens. It has somewhat less depth of focus, but, when used with a large diaphragm, is superior to it in definition.

The same may be said of the triplet manufactured by Ross as of that made by Dallmeyer, with the exception that it gives an image including a smaller angle.

Petzval orthoscopic lens, as we have seen already, gives an image in which the marginal lines, instead of bending inward, bend outward. Architectural subjects may be reproduced by it quite correctly, by tilting the camera slightly upward. The qualities of the orthoscopic lens are great definition and flatness of field.

The double combination or portrait lens is

used in out-door photography, when every other quality has to be sacrificed to rapidity of action, as, for instance, when moving objects have to be photographed. The great defect of the portrait lens is the curved field it gives.

The camera should be perfectly level. If it was pointed downward or upward, the vertical lines in the view would fall inward or outward. If by having the camera horizontal there is too much foreground or too much sky in the image, raise or lower the slide to which the lens is attached.

The most favorable moment to take a view, is when the rays of the sun fall obliquely on the object. When the sun is right behind the camera, the picture produced is too flat. The peculiar manner of illumination depends, however, greatly on the object itself and on the taste of the operator.

The camera should be placed so that the rays of the sun do not fall on the lens, in order to avoid reflections, which would cause fogginess in the picture. When the picture includes a large amount of strongly illuminated sky, and a double or triple lens is used, a light circular spot is seen in the center of the ground glass, which is the more visible as the stop used is smaller. This appearance is known to photographers by the name of *ghost*. Single lenses are not liable to it, it being produced by the reflection of the light from one lens to the other. The only way to

obviate this defect, to some extent, is to cut off the sky part, during the larger part of the exposure, and allow it to impress the sensitive plate for a very short time toward the end. This is easily done by using, as a cover to the lens, a small square board hinged on the upper part, so that it can be raised and lowered. By looking on the ground glass it can be set in such a position that it cuts off the sky. Giving, then, three-fourths of the proper exposure, it is raised more, so as to allow the sky to be impressed, the rest of the exposure is given, and the lens is covered up. As the appearance of the ghost is generally accompanied by a solarized sky, the short exposure given to that part of the image prevents the solarization. When the means described is not practicable, on account of the outline of the sky being irregular, an imperfect remedy is found in adapting in front of the lens a funnel, made of blackened pasteboard, so that all rays, not active in producing the impression, be excluded.

The size of a stop to be used is a matter of consideration for the photographer. The smaller the stop, the longer exposure is required. If the length of the exposure is no object, a small stop should be used, for a superior definition will be the result, and objects, in different planes, will be made equally sharp. For a landscape, in which there is no principal object, to which every

thing else should be sacrificed, if need be, the focus should be taken on a part of the scenery which is half way between the principal objects in the foreground and those in the background. By inserting a stop, every plane is then pictured with sufficient definition. When a picture is wished of a single object, such as a building, or a monument, the focus is taken on a point half way between the center and the edge of the object. In taking the focus, make use of a magnifying glass. Darlot's eye-piece is very well suited to the purpose; it magnifies the image sufficiently to see plainly the smallest details. It is composed of a combination of lenses, set in a tube. This tube itself slides into another tube, and can be fastened at any point, by means of a screw. The eye-piece, before being used, is to be set to the eyesight of the operator. This is done in the following way: Take a piece of ground glass, make a pencil-mark on the ground side, and set it against the window, the ground side outward. Then put the mouth of the eye-piece against it, and draw the inside tube forward or backward, just as in focusing, until you see a sharp image of the pencil-mark, after which you tighten the screw. All the operator has to do now, when he wishes to look at the focus, is to apply it against the ground glass of the camera.

In photographing foliage, a bromo-iodized collodion is necessary. Sufficient detail is

brought out by a long exposure. The image is generally weak, and needs a good deal of redeveloping or strengthening to acquire sufficient intensity. In such subjects, the sky is generally thin from being solarized, unless the contrivance spoken of above, to give a shorter exposure to the sky than to the landscape, be made use of.

CHAPTER XLI.

Instantaneous Photography.

The term *instantaneous*, which has been adopted by photographers, is, in the proper sense, wrong; for the so-called instantaneous pictures are taken in a space of time which is appreciable, as can be seen in many of them, where the outlines of moving objects are found to be less sharp and defined, than those of other immovable objects around.

The conditions required to produce pictures with the shortest exposure are, a good light, the use of a quick-working lens, and the use of solutions in the most sensitive condition.

Pictures of moving objects should only be attempted to be taken by a very good light. The light, as we all know, is most actinic in the spring, between the hours of ten and two, and on a sunshiny day, or while the sky is covered with white clouds. In these condi-

tions, supposing the lens and chemicals to answer all requirements, small portraits of fair complected persons may be taken in a glass room, in from one to three seconds, and outside views as rapidly as the lens can be uncovered and covered up again. A good deal will depend, however, on the subject, for distant landscapes and sea scenes are taken much quicker than street scenes, etc.

The lens is the next thing to be considered. It should be of short focus, and used with a wide aperture. This precludes the use of the single lens and of the globe lens, and of all such lenses which can not be used without small stops. The double combination, or portrait lens, is the one best adapted to this kind of work. It should be of a short focus, and possess every possible excellency, as no small diaphragms can be used to correct its faults. The English opticians manufacture lenses expressly for the purpose. Among these, the only one which came to our notice, is Dallmeyer's *stereoscopic lens*, which, we think, answers all requirements, and is as near to perfection as it can be made. This, we say, without wishing to detract from the merits of the lenses of other makers, having had no occasion to try them.

The most favorable condition of the solutions, as far as sensitiveness is concerned, is the third thing to be considered. The collodion should be made with pyroxyline, prepared

at a low temperature, (about 120 degrees,) and with acids in about equal parts. The character of such pyroxyline, is to give a rapid collodion, producing little intensity. Intensity should always be avoided, for intense collodion never works quick. The aim is to obtain an image sufficiently developed, however thin it may be, and to bring it up afterwards by redeveloping or strengthening. The collodion should also be iodized to the creamy state, and contain a full proportion of bromide. Four grains to the ounce of iodide of ammonium, and three of bromide of cadmium, is a very good proportion. This collodion will keep several weeks in its most sensitive state. Collodion containing nothing but the cadmium salts, only acquires its maximum of sensitiveness after having been kept for several weeks.

The bath should be made with pure fused and recrystalized nitrate of silver, and should only contain a trace of nitric acid. After it has been worked some days, it will be remarked that the plates are not as sensitive as before. In this case there is no remedy but to make a new one. The ordinary iron developer is the one best suited. It may be used in the proportion of one ounce of sulphate of iron to sixteen or twenty of water.

Some precautions should be observed, which are indispensable to success. A rapidly moving object, at a short distance, should be taken moving toward the operator or away from

him, and never while it passes him, for the shortest exposure could not prevent it from being blurred in the picture. Great care should always be taken to admit no diffused light in the camera. To this effect, fix in front of the tube a funnel made of card-board, blackened inside and projecting about six inches, and have your stops between the lenses. Ascertain, also, if no light enters through the sliding tubes, and cover the camera with a black cloth while you are exposing.

The caps with which lenses are provided, can not be taken off and put on again quick enough. A soft hat or cap, or a black cloth, will answer the purpose better. When the exposure has to be shorter than can be given by this means, the drop shutter can be used. It is composed of a thin board, pierced with a hole, the same diameter as the lens, which slides in a groove in front of the lens. The lens being covered by the lower part of the slide, the latter is allowed to drop, and the lens is, for a moment, uncovered. The same arrangement can be used in a horizontal position. In this case, the shutter is provided with an India-rubber spring which is stretched and then let loose again by touching a catch.

It is important, in order to secure the greatest degree of sensitiveness, that as short a time should elapse between the preparation of the plate and the development as is possi-

ble. The operator should thus have his tent, or developing-box, near at hand.

CHAPTER XLII.

Photography on Painters' Canvas.

Ever since enlarged prints on paper were made, it has been the aim of photographers, who practice this branch of the art, to produce similar pictures on the canvas used by painters. The first attempts consisted in salting and silvering the canvas in the same way as the paper; but the coating of white-lead with which the canvas is covered, not being a porous substance, the prints obtained were very faint. A modification of the glass albumen process was then tried. The canvas was washed with an alkali, coated with iodized albumen, silvered, developed with gallic acid, and fixed with hyposulphite. This gave from the start beautiful results, but the process was soon given up, on account of the peeling and cracking of the film of albumen after the photograph had been painted. The writer of this, who was then, and is now, engaged in the enlarging business, substituted a thin solution of gelatine to the albumen, and met with such success that he has continued to use the process ever since. It may be thought that the gelatine, like the albumen, leaving a film on

the surface of the canvas, the image is also liable to peel off and crack, but this is not the case. For, while the film of albumen is horny and like parchment, and consequently adheres but imperfectly, the gelatine film is very porous and adherent, and leaves the canvas in the same state as it was before. It is this process which we now propose to describe; we will divide it as follows:

1. Repainting the canvas.
2. Cleaning.
3. Iodizing.
4. Sensitizing.
5. Exposure.
6. Developing.
7. Fixing and washing.

Repainting the Canvas.

Different kinds of canvas give different results. Some kinds are easily cleaned by rubbing with a piece of canton-flannel, moistened with alcohol; others require rubbing with a sponge and soap-water, to which an alkali has been added. One variety requires a longer exposure than another, and almost every sample gives a picture different in appearance. To work with uniformity, and produce the best results, it is thus advisable to give to the canvas a coat of paint always prepared in a uniform way. The paint we have found to answer the best, is made with one pound of white-lead, ground with oil, and eight fluid

ounces of turpentine, or common petroleum benzine. (The refined petroleum benzine and that made from coal or coal-tar is too volatile.) The white lead is the best kind used for common purposes, and is sold in kegs. The white lead and turpentine are well mixed, and the mixture is strained through a coarse cloth, and applied with a flat varnish brush. After two or three days, the paint is perfectly dry, and the canvas is ready for the next operation.

Cleaning of the Canvas.

The canvas is now rubbed with a piece of canton-flannel moistened with alcohol. The object of this is to take off the greasiness, so that the iodizing solution adheres to the surface. The rubbing should be done gently, so that the paint does not come off. It is sufficient to go over the surface two or three times, after which, the canvas is rubbed dry with a new piece of flannel.

Iodizing the Canvas.

The iodizing solution is prepared according to one of the two following formulas.

Gelatine	200 grains.
Iodide of Potassium	400 "
Bromide of Potassium	100 "
Chloride of Ammonium	100 "
Water	80 ounces.

Gelatine	200 grains.
Iodide of Potassium	400 "
Bromide of Potassium	200 "
Water	80 ounces.

The first solution is used when the negative is thin, and the second when it is intense.

The gelatine is soaked in the water until it is well softened. It is then dissolved by a gentle application of heat, the other ingredients are added, and it is filtered through a tuft of cotton-wool previously moistened with alcohol.

The iodizing solution is applied by means of a flat brush, and the canvas set to dry in a warm room, free from dust. If the coating should dry in lines, the fault lays in the cleaning. It should then be washed off with warm water, and cleaned again.

Sensitizing the Canvas.

The silver solution is prepared according to the following formula:

Nitrate of Silver	1 ounce.
Distilled Water	16 ounces.
Acetic Acid No. 8	2 ounces.

Old collodion silver solutions reduced to the proper strength, and additioned with acetic acid, can be used up very economically in this process.

The silver solution can not be applied with cotton, for the thin film of gelatine would rub off. The way to proceed is as follows: Get a square frame made of walnut, one inch thick, two and a half inches high, and the size of the canvas. Give it several coats of shellac dissolved in turpentine. Then take India-

rubber tubing, one-half inch thick, pass it through a hot mixture of wax and turpentine, let dry, and tack it around the frame with thin nails about one-half inch long, driving the nails through the outer surface of the tube, so that the silver solution can not come in contact with the iron. The canvas is now laid on the tubing and is fastened to the frame by means of wooden clamps. The whole thus forms a tray of which the canvas is the bottom, and which is kept from leaking by the tubing.

To sensitize the canvas, tilt it up to an angle of forty-five degrees, pour the solution in the lower part of the tray, and, by bringing this back to a horizontal position, cause the fluid to flow over the surface. Keep in motion by moving one end of the tray up and down for three or four minutes, and then pour into a bottle. The canvas is now ready for exposure.

The silver solution should be used but once, for it becomes contaminated by the gelatine, and would give foggy pictures. It is best to precipitate it with copper or salt, without waiting till it becomes discolored.

Exposure.

The focus should have been taken previously to the sensitizing. The canvas is then put in the same place on the stand or easel which it occupied before, and the sun is turned on.

The time of exposure varies considerably. It depends on the strength of the light, the intensity of the negative, the proportion of the enlargement, and the formula used for iodizing. The formula, without chloride of ammonium, produces the most sensitive surface, and is, consequently, better suited for intense negatives. The exposure should generally be continued until the image is partly visible. When the negative is intense, it will have to be quite plainly marked, but when it is very weak, it may be necessary to proceed with the development before the least trace of an image can be seen. When negatives are made on purpose for this kind of work, they should be made clear and transparent in the shadows, and without density in the high lights. Such negatives will, with the first formula for iodizing, give the best prints.

How long the exposure will have to be, is, as can be concluded, from what we have already said, entirely a matter of judgment, guided by experience. We have made canvas pictures in five seconds, and at other times have been obliged to expose eight and ten minutes.

Development of the Image.

The image is developed with a solution of gallic acid, slightly acidulated with acetic acid. The strength of this solution varies according to the temperature. In warm

weather, the saturated solution, diluted with twice its bulk of water will answer. In cold weather, it may be used twice as strong. Very little difficulty will be found in this part of the manipulation, for if a weak solution is used, the only trouble is that the image will come out slowly.

The gallic acid solution is flowed over the surface of the canvas in the same way as the silver solution.

If the development proceeds too slowly, from under exposure, or any other cause, it can be activated by adding a little silver solution and a few drops of a solution of acetate of ammonia, or acetate of soda.

When the image is fully brought out, further development should be stopped, by adding a few drachms of a solution of common salt. The canvas is then rinsed, and is ready for the next operation.

Fixing and Washing.

The fixing is done with the ordinary solution of eight ounces of hyposulphite of soda in one quart of water. It is advisable to perform this operation after the canvas is taken off the frame, for if any hyposulphite remained on the wood, or got in the tubing, the next attempt would result in a failure, the canvas becoming entirely black on applying the developer. The hyposulphite solution is poured over the surface, and flowed forward and back-

ward, after which, the picture is washed under a tap for five or ten minutes.

OBSERVATIONS.

After a picture has been made, the frame is washed, by means of a sponge, with soap-water, to which a little cyanide of potassium has been added. It is then rinsed in an abundance of water and set to dry.

A canvas which has been used, is also cleaned with soap-water and cyanide. It will generally have to be painted over again, for the cyanide solution will take off part of the paint.

The quantity of silver solution to be used for a twenty-nine by thirty-six picture, can, by skillful manipulation, be reduced to eight or ten ounces. The silver can be precipitated out of this solution by copper or salt, and afterward transformed again into nitrate.

CHAPTER XLIII.

BINOCULAR VISION — THE STEREOSCOPE — HOW TO TAKE STEREOSCOPIC PICTURES.

WHEN a solid object is examined with both eyes, each eye receives different impressions, the right eye seeing more of the right side of the object, and the left more of the left side. These two impressions combining together,

form an image, which conveys to the mind of the observer the relative proportions of the object examined better than if the object was viewed by either eye separately. In other terms, the object is seen more solid.

If from the object, which we will suppose to be a marble bust, two photographs are taken from two points, two and a half or three inches distant from each other, and the left hand photograph is examined by the left eye, while the right hand one is examined by the right eye, the two images will resolve themselves in one, and the bust will have the appearance of being solid, or standing out in relief.

To facilitate the examining of such pictures, an instrument is used which is called a *stereoscope.* A stereoscope is a box made of wood or board, fitted at one end with two lenses, or prisms, at a distance, from center to center, of two and a half or two and three-fourth inches. The two pictures, mounted side by side on a piece of card-board, are called a *stereograph.* The stereograph is placed at one end of the box, at about six inches from the lenses. The stereoscope has, in the middle, between the lenses, a piece of board or wood, which divides it in two compartments, so that each eye can only see one image.

It is easy to understand that only *solid* objects can be used as subjects for the stereoscope. For if a drawing or engraving be con-

sidered with each eye separately, the image conveyed to one is exactly the same as that conveyed to the other. Solid objects at a great distance, also, do not appear in relief, and photographs of them, taken from two points corresponding to the eyes, will have no stereoscopic effect when examined in the stereoscope.

Stereoscopic pictures are generally taken by means of a camera fitted with two lenses, of equal focal length and rapidity of action. Such a camera is called *binocular*. The lenses best adapted to the purpose are those of shorter focus, as they allow a wide angle of view to be included. For groups or indoor work, the double combination or portrait lenses are, of course, the most useful. They should be of the quarter or third size, and not over four and a half inches in focal length. For moving out-door scenes, they are also to be preferred, as they allow of being used with a larger diaphragm, thus giving a very luminous image. For landscapes, two single meniscus, of short focus, are recommended, or, in case pictures are wanted including a very wide angle of view, the two and a half or three-inch focus globe lens.

When the object is at a short distance from the camera, or when the picture includes many objects in the foreground, the stereoscopic effect is all what can be desired. But when the principal object is at a considerable

distance, and the foreground presents an even surface, such as a sheet of water or a lawn, no relief is perceptible, and it becomes necessary to make the two pictures from two points wider apart than the distance between the eyes. It is true, the effect will then be unnatural, for beyond a certain distance the eyes perceive no relief. What is wanted, however, is to make distant objects appear as if they were taken from points nearer to them, for otherwise they would be but uninteresting subjects in the stereoscope. No positive rules can be given as to the separation between the two positions. One foot for every fifty feet distance from the main object, will, however, generally be found to answer.

To make stereoscopic negatives from two points distant more than two and a half or three inches, use a small camera with a double plate-holder, so arranged that only half of the plate be exposed at a time, the other half remaining covered by the slide. This camera is made to slide right and left on a frame of oblong shape, two or three feet long. The frame itself is fixed to the tripod stand by means of a screw, driven in the center of the front part. The way to operate it is as fol-follows: Slide the camera in the center and focus, then move it toward the left, turn the frame so that the objects occupy the same position on the ground glass which they did when the camera was in the center, and make

the left hand picture on the right half of the plate. Now slide the camera toward the right, turn the frame in the opposite direction so that the objects to be represented fall again in the same place, and make the right hand picture on the left half of the plate. The right and left positions of the camera can be indicated by putting a peg on each side, in holes provided for the purpose. To regulate the motion of the frame, mark in the middle of the back part, an arc of a circle, of which the center is the screw by which the frame is fastened to the tripod stand. This arc of a circle should be divided in sixteenths of an inch. A small hand is fixed to the stand. When focusing, the hand and center division should correspond. In making the right hand picture, the frame should be moved as many divisions to the right as it was to the left.

In mounting stereographs printed from negatives made with the binocular camera, the position of the prints should be inverted; that is, the left hand print should be brought to the right, and the right hand one to the left. When the negative is made with the one-lens camera, as described above, the respective positions of the prints are maintained. Care should be taken that the two pictures be not more distant from center to center than two and a half or two and three-fourths inches, this being the ordinary distance between the eyes. Two and three-fourths is generally

preferred, as it allows more subject to be included, and requires but little strain on the eyes in case these should be nearer together.

CHAPTER XLIV.

Transparent Positives—The Opaltype—Enlarging Negatives.

If a negative be put against a pane of glass in a window, and be copied with the camera, by means of the wet collodion process, the copy produced will be a transparent positive. This means of producing positives is very simple, but is quite imperfect, for the following reasons: 1st. The diffused light which enters the camera from all sides, causes the image to be fogged. 2d. The action of the light is not equal on all parts of the plate, the lower part being less acted upon than the higher part. The remedies to these defects are easily suggested. 1st. All light should be excluded except that which comes through the negative. 2d. Instead of the light of the horizon, the light of the zenith should be used; that is, the camera should be raised at an angle of about forty-five degrees toward the north, and the negative put in a position parallel to it.

An apparatus well adapted to the produc-

tion of transparent positives is a long box, at one end of which is a groove for the negative, and at the other end, one for the ground glass or plate-holder. The lens should be halfway between the two, when the print has to be of the same size; nearer the negative when to be larger, and nearer the ground glass when to be smaller. The best arrangement is, to have the groove for the board holding the lens, and that for the ground glass, moveable forward and backward. The distance between the negative and lens, and lens and ground glass, and consequently the length of the box, depends on the equivalent focus of the lens. The longer the focus of the lens, the longer the box has to be.

Instead of the apparatus just described, an ordinary solar camera can be used to good advantage. The condensing lens is removed, and when the sun shines, a ground glass is put in its place. The negative is put in the rack, and the image produced by the lens is projected on the ground glass of a camera placed on a solid stand. The reflector, or heliostat, is worked in the ordinary way. When the sky is covered, it should be kept as much as possible in the position it would occupy if the sun was visible.

The lenses most suitable are those which give a flat field and great definition. The orthoscopic, and either Ross' or Dallmeyer's triplets, are the best for this purpose. Single

lenses and portrait lenses can also be used in some cases.

Negatives made on purpose to produce transparent positives, should be thin and transparent, and possess great detail. The collodion used should be new, and with a full proportion of bromide, so that it works with little contrast. When a transparent positive is to be made of an intense negative, the aim should be to procure collodion producing so little intensity, that for ordinary purposes it would be worthless. The silver bath and developer are the same as for ordinary work. The time of exposure should be regulated, so that the half tones be well reproduced. The fixing is done with cyanide of potassium. After fixing and washing, the picture requires to be toned. This is done by blackening the film with a solution of bichloride of mercury, washing, and then applying a one-grain solution of chloride of gold.

The *opaltype* is made in the same way as the transparent positive, using opal instead of transparent glass. The opaltype is examined either by reflected or transmitted light. It is a very beautiful style of picture, which promises to become very popular on account of its pure whites, and the facility with which it takes dry colors.

The apparatus described above can be made very useful for copying and enlarging negatives. This is done by copying a transparent

positive from the original negative, and then copying this positive again to a negative in the same way. The success of the operation depends mostly on the qualities of the transparent positive. It should not be larger than a half plate, be made with an excellent instrument, and the exposure timed so that no detail be lost. It is not necessary to tone it with bichloride of mercury and gold.

Negatives enlarged by this process possess many advantages over those made directly with a large lens. Where the use of mammoth cameras requires one or two minutes of exposure, thus trying greatly the patience of the sitter, a negative for enlarging is produced in ten or twenty seconds. On the other hand, large lenses are always less perfect than small ones. A half or quarter size portrait lens will, at a certain distance from the sitter, produce an image practically correct in proportion, when a mammoth size will, at the same distance, reproduce the original out of shape. Examine, on the other hand, a head, three-fourths or one inch in size, made with a good half size lens, and you will find every part sharp and well defined. A head made with a mammoth camera possesses no such qualities. If the focus is taken on one plane, the other planes will appear blurred; so we see, in most large pictures, the eye well defined, and the hair, beard, and shoulders out of focus. This defect is, of course, reme-

died, to some extent, by the use of stops; but this, again, increases the time of exposure.

The original negative made for enlarging, should not be larger than quarter or half size. It should be made with greater care than is generally taken for ordinary negatives. The collodion should be thin, and made with the best pyroxyline, so that the film be structureless. Clean manipulation is indispensable; in short, the operator should keep in mind, that the least imperfection will become more apparent in magnifying.

The process described has this great advantage for enlarging over the solar camera process, that it can be practised in all kinds of weather. The photographer is thus enabled to make his enlarged negatives on dull days, when he is not otherwise occupied, while the solar camera can only be used on clear days, when he is generally kept busy in the portrait room.

CHAPTER XLV.

RECOVERY OF SILVER FROM OLD SOLUTIONS—PAPER CLIPPINGS, WASHINGS, ETC.

As only a small quantity of the silver used in photographic processes, goes to constitute the image, it is greatly to the interest of the photographer to keep the washings, and other

wastes, in order to recover the silver they contain.

Old solutions out of order, either those used for sensitizing collodion plates, or for preparing paper, are precipitated by leaving them in contact with a copper plate. The metallic silver thus obtained, is well washed, redissolved in nitric acid, evaporated and fused, until the small quantity of nitrate of copper, which is always present, is decomposed. The nitrate thus obtained can then be used as it is, or recrystalized.

The development and redevelopment should be done over a tub or barrel. The mud which collects at the bottom, contains a large amount of metallic silver.

The washings of the prints before toning, are all poured into a tub or barrel, in which are put some plates of copper. The next day all the silver is precipitated, and the clear liquid can be drawn off.

The scraps of silvered paper, which have not passed through the hyposulphite, the blotting paper used to absorb the drainings in the plate-holder, the filters used for filtering silver solutions, etc., are burned in an iron pot, standing in the open air. The ashes contain chloride and metallic silver.

The cyanide and hyposulphite are deprived of their silver by plates of copper. It takes two or three days to precipitate all the silver the solution contains. The precipitate is me-

tallic silver mixed with a small quantity of sulphide. The clear hyposulphite can be used over again to fix negatives.

The metallic silver, ashes, etc., may be put together and given to the refiner. When this is done, care should be take to wash perfectly the precipitate of the hyposulphite solution. It is best, however, to keep this precipitate apart, as it may, sometimes, contain a great deal of sulphide, which is more difficult to reduce to the metallic state than other silver compounds.

The different recommendations we make here, are those described by Messrs. Davanne and Girard, who have made the reducing of wastes a special study.

We would not recommend to the photographer to reduce his wastes himself; we consider it his interest to leave this to the chemist or refiner, who have the necessary practical knowledge, and possess the necessary apparatus to accomplish this end. We will, however, briefly describe the different processes.

Metallic silver, precipitated by means of copper, may, as we have already mentioned, be directly transformed into nitrate of silver, by dissolving in nitric acid. Chemists, however, prefer to melt the silver before converting it again into nitrate. This is done as follows:

The silver powder, washed and dried, is

mixed in a mortar with half its weight of fused and pulverized borax, and one-fourth of its weight of fused and pulverized nitre. A crucible is then put in a good furnace, and made red-hot, when the mixture is thrown into it, little by little. When the ebullition has ceased, the fire is increased, and the crucible is kept white-hot for fifteen or twenty minutes, after which it is left to cool, when it must be broken to remove the button of silver.

The waste resulting from development and redevelopment, can be mixed with the silver precipitated by means of copper, when this is melted, or if this is transformed into nitrate, without being previously melted, it is added to the ashes of the burned paper. The ashes of burned paper are mixed with half their weight of dry carbonate of soda, and one-fourth of their weight of quartz sand, and reduced in a crucible in the manner described before.

If the metallic silver and the ashes are put together, the whole mass is fused with carbonate of soda, nitre, and sand.

When the precipitates contain sulphide of silver, the reduction is more difficult. It is necessary, then, to keep the mass at a white-heat for at least an hour.

The method generally used by photographers is, to precipitate their washings by means of salt. This method is good enough when

the silver solution is of a certain strength, but when the water contains but a small amount of silver, quite a quantity is lost by the chloride not all settling to the bottom, or by dissolving in an excess of salt. The use of copper, instead of chloride, secures the precipitation of all the silver the water contains.

The process of precipitating the silver out of the hyposulphite solution, by means of sulphide of potassium, is also inferior to the one we describe above. The precipitate obtained is sulphide of silver mixed with sulphur, and before it can be reduced in the crucible, which itself is an operation attended with many difficulties and accidents, it has to be roasted; that is, the sulphur has to be burned up by heating the precipitate on an iron plate.

To save the gold of old toning baths, acidify them with hydrochloric acid, and add a small quantity of a solution of iron. This will precipitate the gold in the metallic state. Separate the precipitate by filtration, wash well and redissolve in nitro-hydrochloric acid. An acid solution of chloride of gold is then obtained, which is neutralized by leaving it in contact with a piece of chalk. When all effervescence ceases, and the solution is neutral to test-paper, filter, and use it for toning.

CHAPTER XLVI.

Removing Stains from the Skin, Linen, etc.

Stains of nitrate of silver can be easily removed from linen, by the application of a saturated solution of hypochlorite of lime, (chloride of lime.) This requires from one to five minutes. In this case, the metallic silver is changed into white chloride.

Instead of chloride of lime, the following solution can be used:

Cyanide of Potassium	1 ounce.
Water	16 ounces, fluid.
Dry Iodine	1 drachm.

This solution is applied with a small brush. It removes the stains in a few seconds.

Hyposulphite of soda may be substituted to the cyanide of potassium, in which case, the stains will not be removed so quickly. Subsequent applications of tincture of iodine and cyanide of potassium, or hyposulphite of soda, will also produce the same effect.

The same substances which remove the stains from linen will remove them from the skin.

When the color of the fabric is liable to be injured by the chloride of lime, or cyanide of

potassium, the solution of iodine in hyposulphite of soda is preferable.

Iron stains are removed by the application of a weak solution of oxalic acid.

Stains of collodion will dissolve in a mixture of ether and alcohol.

Iodine, cyanide of potassium, oxalic acid, and chloride of lime, having a corrosive action, these substances should be removed by rinsing the linen in clean water, as soon as their full effect is produced.

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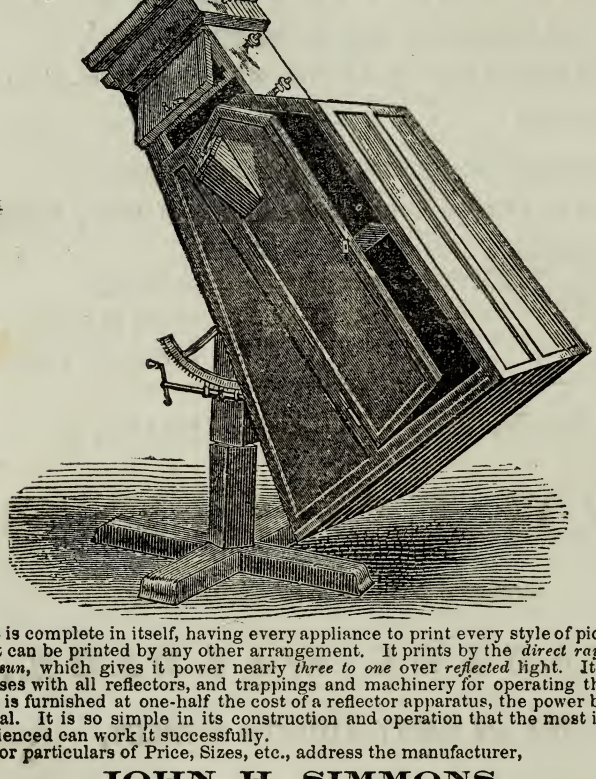

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